Intel® Applied Computing Solutions Guide

For Industrial PC and Transaction Terminal Platforms

February 2000

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1.0 Introduction

1.1 Purpose and Audience

This Solutions Guide describes to system developers, system integrators, and single-board computer manufacturers a well-defined set of platform building blocks and design considerations for two applied computing market segments: industrial PCs and transaction terminals. This document provides recommended platform configurations to help system developers select hardware components for designing applications for these segments. It describes the platform building blocks, including silicon components, operating systems, and development tools, and provides thermal and form factor design considerations for shortening the development cycle of these applications. A major portion of the document focuses on the platform configurations and building blocks provided by Intel.

1.2 Scope and Structure

The industrial PC market segment is broadly defined to encompass PC-based applications such as panel PCs, industrial workstations, ruggedized notebooks, and single-board computers in various form factors for rack-mount usage. These industrial PC applications are widely deployed in the automation and control, military, transportation, and test and measurement market segments.

Transaction terminals are defined as point-of-sale (POS) terminals, automated teller machines (ATMs), services terminals, and various types of interactive information kiosks.

This document overviews the platform building blocks for industrial PCs and transaction terminals, including the hardware, software, performance, and support considerations particular to these applied computing market segments. Platform reference configurations are provided for low-power, value, and high performance designs in each market segment.

The document also discusses Intel initiatives for power management, describes software considerations, and lists software and hardware development tools to assist in the design process.

The appendices list related resources and hardware suppliers, and provide schematics for a sample design.

1.3 Revision History

Revision Number	Date	Description
1.0	02/2000	Specified previously unannounced processors, chipsets, and other components of the reference configurations.
0.9	09/1999	Preliminary public version.

2.0 Applied Computing Platform Building Blocks

This section presents a summary of the basic building blocks for applications targeted at the industrial PC and transaction terminal market segments. These basic building blocks apply to many other applied computing applications.

2.1 Extended Product Life Support

A critical consideration when designing for the applied computing market segments is ensuring that the platform building blocks have extended product life support. Applications in the applied computing market segment typically require longer life support for the platform building blocks compared to the PC industry, due to the slower rates of product upgrades and obsolescence. The nature of these applications, which demand high availability ("up-time") and constant quality of service over an extended period of time, does not favor regular changes or significant upgrades to the designs or applications. Thus, providing longevity in well-proven solutions (both hardware and software) is often more important than upgrading the design to the latest platform solutions with the greatest performance and features. Intel's platform reference configurations specified in this document address this need by implementing Intel components that provide extended product life support. These components include the microprocessor, system chipset, PCI-to-PCI bridge, graphics controller, Ethernet controller, and flash memory.

Intel's platform reference configurations provide a well-defined set of building blocks with extended product life support. Ensuring long life support on the platform building blocks is critical to system developers and integrators due to the longer product life cycle of applied computing applications.

2.2 Graphical Interfaces

Applied computing applications are becoming increasingly graphics intensive and are moving from text-based input to user-friendly graphical user interfaces (GUIs). Applications such as point-of-sales (POS) and information kiosk terminals are taking advantage of the rich multimedia and graphics capabilities enabled by the advancement in hardware and software solutions to provide a richer interactive experience to the consumers.

The graphics controller is the key component that works with the processor to handle graphics processing. A typical interface to the graphic controller is through either the PCI bus or Accelerated Graphics Port (AGP). The output of the graphics controller is typically directed to a flat panel display or a CRT monitor. Typical features of a graphics controller in industrial PC and transaction terminal applications include the following:

- Provides a minimum of 2-D graphics acceleration through hardware.
- Uses a 33 MHz PCI bus interface to the host CPU and to the AGP port.
- Offers an option to provide a digital interface to an LCD or through an external transmitter and receiver. Supports DDC 1/2 standards.
- Provides a minimum of 16-bit color, 800x600 resolution, and supports 16:9 aspect ratio panel (1024x600) and quarter VGA (320x240, 320x200). Uses an integrated frame buffer (minimum 2-Mbyte) and DAC.

2.3 Applied Computing Form Factors

Applied computing applications often require a smaller-sized board compared to regular PC motherboards. This includes single-board computers that fit into the back planes of rack-mount chassis. To accommodate a compact design, the components, including the processor, must be in low profile packaging and preferably have low power consumption for simple thermal designs. Some of the more popular form factors for single-board computers used in rack mounted applications are CompactPCI* and PCI-ISA, governed by the PCI Industrial Computing Manufacturing Group (PICMG), and the well-established VME standard. Each of these standards has unique specifications that describe the form factor in terms of hardware, mechanical, and thermal designs.

A socketable solution for the microprocessor(s) is highly desirable in industrial PC and transaction terminal applications, including single-board computer designs. The socketable solution provides flexibility and easy scalability for motherboards and single-board computers for embedded applications. Some considerations for choosing the processor form factor include:

- Package size/type, such as Ball Grid Array (BGA), and surface mount packaging that accommodates space constrained designs and meets robust connectivity under harsh environments
- Socketability for system scalability and flexibility
- Package electrical, thermal, and mechanical characteristics
- Printed circuit board (PCB) space availability

2.4 Computing Performance Considerations

In the past, embedded applications have lagged the PC industry in adopting the latest microprocessor and PC technologies. Now, however, an increasing number of embedded applications are adopting the latest microprocessor offerings. For high performance applications, multiprocessing capability with a large system memory may be required. Other designs may have low power consumption requirements or space constraints which do not allow implementing cartridge packaging or fans. Intel’s platform reference configurations provide the latest microprocessor and chipset solutions to meet the needs of low power, value, and high performance applications.

For high-performance applications, microprocessors and chipsets that support dual processing may be needed to deliver the required performance output.

2.5 Networking

Networking capability has become a basic requirement for many applied computing devices, due to an increased need for remote access and control and for sharing data with other devices. This has been enabled by a significant reduction in the cost of communication. The communication bandwidth requirement is also increasing, moving from 10 Mbps to 100 Mbps in the near future. Currently, the most commonly used network access method is Ethernet and the interface with the host system is typically required to meet PCI 2.2 specifications. The basic requirements of networking must be met in order to achieve better system management.

A desirable networking feature is compliance with the Advance Configuration Power Interface (ACPI) specification. This specification defines an interface between the operating system (OS) and the hardware and BIOS that is designed to achieve independence between them. Additionally, it is recommended that the PCI interface comply with PCI Bus Power Management Interface Specification. See the following URLs for additional information.

http://www.teleport.com/~acpi
http://www.pcisig.com

2.6 Clock Generators and Drivers

Clock generators provide clock signals to the processor, system logic, memory, and other supporting logic components. For Intel® architecture (IA) platforms, Intel provides the clock synthesizer specification for clock vendors to ensure that future processor clock requirements are met. Please refer to the Intel's *Clock Synthesizer Design Guidelines* for more information on clock generators (see Appendix A, "Related Resources" for the URL).

Clock synthesizers are expected to source multiple clock types, including the Host clock, PCI clock and others as defined by the IA system. The platform reference configurations discussed in this document deal with the CPU clock, other Host bus clocks, PCI clocks, IOAPIC clocks, 48 MHz, and copies of the reference clock. Clock generators are also used to generate fixed frequency 66 MHz outputs.

2.7 Legacy-Free Systems

Newer I/O and bus interfaces have developed incrementally since the introduction of the first PCs. The older interfaces do not support the performance model or functional capabilities used by the latest PC architecture. PC systems are in the process of phasing out legacy components such as ISA slots, ISA devices, Super I/O* (SIO) and I/O connectors. Newer I/O and bus interfaces such as PCI, AGP, and USB provide superior functionality and performance. Industrial PC and transaction terminal systems typically use a high number of I/O interfaces; interfaces such as USB may satisfy such requirements.

ISA expansion slots are often no longer required because many functions such as audio, LAN, and IDE have evolved beyond the limited functionality and bandwidth of the ISA bus. This has been accomplished by moving to other buses and interfaces, including PCI, AC-97, and USB. The Super I/O functionality is being migrated to the LPC (Low Pin Count) bus in anticipation of ISA removal. As a result of the removal of the ISA bus interface, the system motherboard size can be reduced. Additional benefits of removing the ISA slots include the removal of the -5 V DC rail (which is only used by ISA slots), improvements in the thermal solutions (by reducing barriers to airflow), and reduction in the chassis size.

The PS/2 interface may no longer be required, as the USB interface provides support for the keyboard and mouse. The USB keyboard and mouse provide full functionality under USB-aware operating systems, including the BIOS that supports USB.

Similarly, the serial and parallel port connectors may be removed, as equivalent USB peripherals are available and capable of supporting multiple “hot- attached” peripherals. USB-to-LPT and USB-to-COM adapters are also available to support legacy peripherals.

For more information on legacy-free systems, please refer to *PC 99 system Design Guide* and *Easier To USE Consumer PCs in 1999* (see Appendix A for the URLs).

2.8 Software and Operating System Considerations

An increasing number of embedded applications are adopting standard operating systems used in the PC industry in addition to well-established real time OSs. Many third party software vendors are providing complementary software solutions that enable the Microsoft Windows* operating system to address the needs of embedded systems, such as real time performance, determinism, and small (software) footprint. For those embedded applications that require precise real time operations, using a dedicated real time operating system may be the best solution.

3.0 Industrial PC Solutions

3.1 Overview of the Industrial PC Market Segment

The industrial PC market segment is broadly defined to encompass PC-based applications typically deployed in industrial or harsh environments. These applications include panel PCs, industrial workstations, ruggedized notebooks, and single board computers. Single board computers are usually attached to passive or active backplanes in rack-mount systems. These applications are typically designed to withstand high temperature, shock vibration, EMI, RFI and other external interferences in harsh conditions.

An increasing number of OEMs and system integrators are designing PC-based systems for industrial PC applications to leverage the benefits of a shorter development cycle. By using open standard components, OEMs can design cost effective PC-based solutions that can be easily customized to meet a wide variety of requirements. PC-based systems provide the flexibility and scalability to meet the requirements of diverse applications found in the industrial PC market segment. The rapid growth of the Internet is accelerating the need for connectivity in industrial PC applications, particularly in factory floor automation and control systems. PC-based systems are well-suited to handle connectivity using Ethernet or other communication protocols. The trend to implement user-friendly graphical interfaces in industrial PC applications, such as panel-mounted PCs and control systems, is another factor driving the adoption of PC-based systems. These applications can use existing real time operating systems that run on PC-based systems and support rich graphics and multimedia interfaces.

One of the challenges for system developers in the design of Industrial PC applications is the hardware component selection process. Using PC building blocks for Industrial PC applications brings a lot of benefits as described earlier, however, the rate of component obsolescence is very much faster in the PC industry that does not fit too well in the Industrial PC market where extended product life support is a requirement.

One of the objectives of this document is to address the hardware component selection process, particularly relating to components supplied by Intel. Industrial PC applications can be categorized into three segments.

Performance segment	Applications in which performance is the primary consideration.
Value segment	Applications that balance performance and cost.
Low-power segment	Applications for which low-power consumption and thermal design are the key considerations.

Intel provides a recommended platform reference configuration to address the unique needs of each segment. The recommended platform configurations are optimized for each segment based on the primary requirements. The Intel components recommended in the reference configurations are specially selected to provide extended product life cycle support to meet the needs of industrial PC applications.

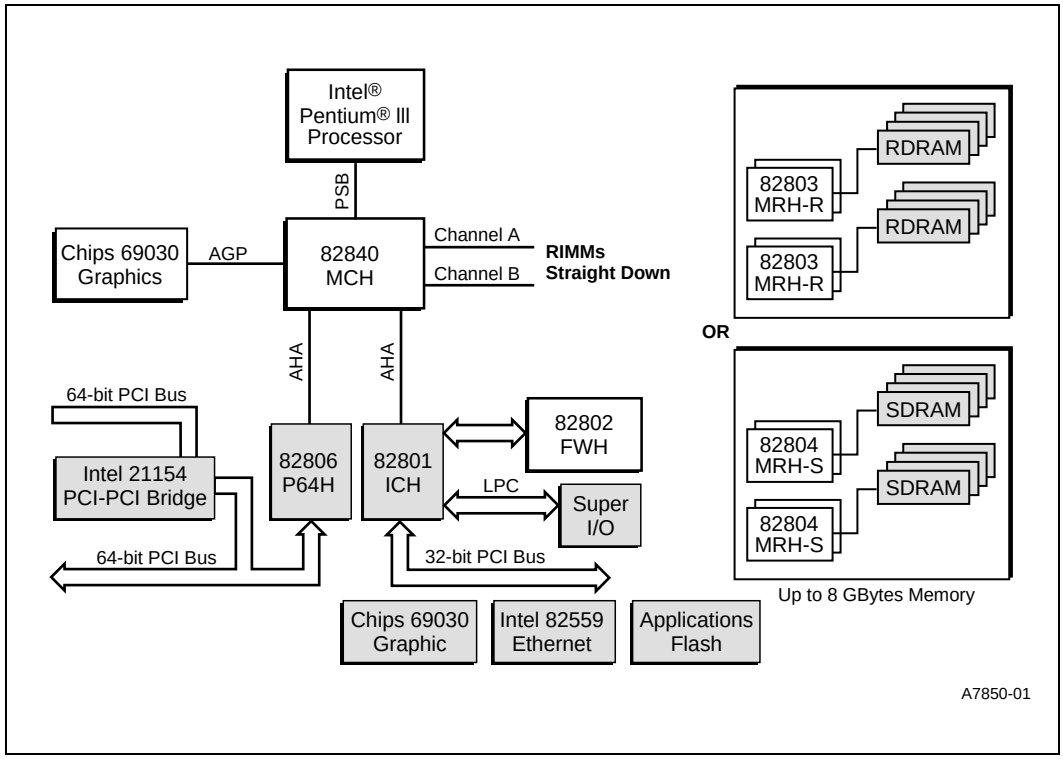
3.2 Industrial PC Performance Platform Reference Configuration

Intel's performance platform reference configuration for industrial PCs enables high performance desktop computing capability in the embedded market segment. The Intel Pentium® III processor is currently Intel's most powerful processor for desktop PCs, offering developers the power and performance to provide greater productivity and increased manageability. The Intel® 840 chipset was specifically designed to meet the needs of high performance multi-processor systems. The 840 chipset, together with the latest Intel Pentium III processors, provides new levels of performance, scalability, and end user productivity. The industrial PC performance platform provides an optimized solution that enables designers to incorporate the latest PC technological innovation while addressing the unique requirements of embedded applications.

Table 1. Industrial PC Performance Platform Reference Configuration

	Recommended Component	Packaging Type
CPU	Intel® Pentium® III processor @ 600 MHz	Socket 370-FCPGA
Chipset	Intel 840 Chipset	Ball Grid Array
Graphics	Chips 69030	Ball Grid Array
LAN	Intel 82559	Ball Grid Array
Bridge	Intel 21154	PQFP
Flash	Intel Flash 1-8 Mbit	Various surface mount package

Figure 1. Industrial PC Performance Platform Block Diagram



3.2.1 Processor and Chipset

Intel's performance platform reference configuration for industrial PCs is based on the Intel Pentium III processor at 600 MHz and higher. The Intel Pentium III processor, Intel's most advanced and powerful processor for desktop PCs and as well for performance industrial PC applications, integrates the best attributes of the P6 microarchitecture processors—dynamic execution performance, a multi-transaction system bus, and Intel MMX™ media enhancement technology. In addition, the Pentium III processor offers Internet Streaming SIMD Extensions and 70 new instructions enabling advanced imaging, 3-D, streaming audio and video, and speech recognition applications. The performance platform supports dual processing capability.

The Intel 840 chipset is designed for Intel Pentium III processor architecture. This chipset consists of three main components: the 82840 Memory Controller Hub (MCH), 82801 I/O Controller Hub (ICH), and 82802 Firmware Hub (FWH). Architectural expansion is provided with 82803 Memory Repeater Hub-RDRAM (MRH-R), 82804 Memory Repeater Hub-SDRAM (MRH-S), and 82806 64-bit PCI Controller Hub (P64H). The Intel 840 chipset components are interconnected via an interface called Accelerated Hub Architecture.

The Intel 840 chipset is designed to support a 100/133-MHz system bus, AGP 4X, dual RDRAM channels, Ultra DMA/66, Low Pin Count (LPC) interface, and Universal Serial Bus (USB). This chipset architecture enables a new security and manageability infrastructure through the Firmware Hub component. A custom set of features provides a consistent pre-boot environment and enables a protected infrastructure for the storage and update of platform code and data. The Intel 840 chipset is also ACPI compliant and supports Full-on, Stop Grant, Suspend to RAM, Suspend to Disk, and Soft-off power management states. Through the use of an appropriate LAN device, Intel 840 chipset also supports wake-on-LAN* for remote administration and troubleshooting.

Contact your Intel representatives for additional product information or see the Intel Industrial PC Platform web site at the following URL:

http://developer.intel.com/platforms/applied/indpc/index.htm

3.2.2 Voltage Regulator

The voltage regulator module (VRM) supplies the required voltage and current to the processor. The voltage regulator module specification defines a range of DC-to-DC converters to meet the power requirements of the platform using Intel microprocessors.

For additional information, please refer to *VRM8.4 DC-DC Converter Design Guidelines* at the following URL:

http://developer.intel.com/design/PentiumIII/designgd/245335.htm

3.2.3 Clock Generators

Clock generators provide clocks to the processor, system logic, memory, and other on-board logic. For Intel architecture platform reference configurations, Intel has provided the clock synthesizer specification for clock vendors to ensure that future processor clock requirements are met.

For additional information, please refer to *CK98 Clock Synthesizer/Driver Design Guidelines* at the following URL:

http://developer.intel.com/design/pentiumiii/designgd/245338.htm

3.2.4 Memory

The performance platform reference configuration for industrial PCs is defined as having performance equivalent to that of a current desktop PC. Typically, the memory technology used in this segment is 300 MHz/400 MHz RDRAM.

Application software in the performance platform manipulates and operates upon large data sets. Consequently, this platform supports at least 2 Gbyte of main memory. The Intel 840 chipset directly supports dual RDRAM channels, and with external memory repeater hubs (MRH-R) for RDRAM devices, up to 8 Gbyte of memory can be supported.

Data integrity is frequently a critical component of applications within the performance industrial PC market segment. Therefore, Error Checking and Correction (ECC) on DRAM is a feature of this reference configuration.

3.2.5 Graphics

In the performance platform reference configuration for industrial PCs, a highly integrated graphics controller is preferred and should be implemented on board using either the AGP Frame or PCI bus. This reference configuration supports dual and independent display output. It also supports flat panel display and a display resolution of 1280 x 1024 x 24bpp.

A host interface through Frame AGP frees up PCI electrical load and reduces PCI bus bandwidth usage. The additional PCI electrical load and PCI bandwidth can be used for other PCI devices, increasing the overall system performance.

For the performance platform, the recommended graphics controller is CHIPS 69030. The 69030 is a highly integrated, second generation of the HiQVideo™ series graphics controller, integrate high performance SDRAM frame buffer memory by using leading edge embedded memory logic technology. By embedding SDRAM memory and graphics controller logic on the same die, the 69030 delivers uncompromised performance while consuming much less power than the discrete solution. The integrated 4 Mbyte SDRAM supports 100 MHz operation and provides up to 800 Mbyte/s frame buffer bandwidth. The increase in frame buffer bandwidth enables the 69030 to support hi-color, hi-resolution graphics modes, dual displays for CRT/TV, and Flat Panel and real-time video acceleration. The additional bandwidth and memory size also allows more flexibility in other graphics functions used intensely in Graphical User Interfaces (GUIs). Some of the key features of the 69030 graphics controller include:

- **Dual Independent Display**: Integrated SDRAM and up to 800 Mbyte/s frame buffer bandwidth enables true dual display support. Two multimedia engines are implemented to enable video acceleration on both display pipelines.
- **2-D Acceleration for All Modes**: The graphics engine is designed to enable high performance system platforms. The 69000 boosts the 2-D performance through specialized hardware that accelerates the most frequently used 2-D GUI operations.
- **Versatile Panel Support**: The graphics engine supports a wide variety of color and monochrome SS, DSTN, TFT, EL and Plasma panels. Using HiQColor™ technology, up to 16.7 M colors can be displayed on passive DSTN panels. Up to 16.7 M colors can also be supported with 24-bit TFT panels.
- **Footprint/ Package**: The 256-ball BGA or mini-BGA packages are available, and suited for applications where PCB real estate is critical.
- **Flexible Host Bus Support**: The 69000 provides a glueless interface for both PCI and Frame AGP host buses which enable a wide range of applications.

- **Multimedia Video**: The 69000 implements a variety of features to deliver high quality, full-screen, full frame-rate video capture and playback for MPEG1, MPEG2, V-CD and DVD.

For more information on the 69000, please refer to the following URL:

http://developer.intel.com/design/graphics/mobilegraphics/products/69030/69030.htm

3.2.6 Networking

The Intel 82559 Fast Ethernet Multifunction PCI Controller is used to implement the network interface for the performance platform. The 82559 is Intel's second generation fully integrated Fast Ethernet Media Access Controller (MAC)/Physical Layer (PHY) device. The 82559 has the following key features:

- Wired for Management (WfM) - improves manageability and decreases the total cost of ownership. For further information on WfM, please refer to Section 5.1, "Wired for Management" on page 36.
- Wake On LAN (WOL) - a remote wake-up technology using "Magic Packet" and "Packet Filtering."
- System Management Bus (SMB) - for advanced management support
- PC99 compliance

For additional information on the 82559, please see the following URL:

http://developer.intel.com/design/network/

For specific design information, please refer to the following publications (see Appendix A for the order numbers and URLs).

- *LAN On Motherboard (LOM) Design Guide* application note (AP-392)
- *82559 Printed Circuit Board Design* application note (AP-399)
- *Alert On LAN Design Guide* application note (AP-388)

3.2.7 Bridges

PCI-to-PCI bridges for performance industrial PC platforms can be implemented to provide a 64-bit I/O interface. PCI-to-ISA bridges are recommended only for platforms that use host legacy ISA peripherals.

The Intel 21154 PCI-to-PCI Bridge is implemented as PCI-to-PCI bridge on the performance platform reference configuration. The Intel 21154 is designed for PCI version 2.2 compliance with 64-bit primary and secondary interface.

3.2.8 Super I/O* or Ultra I/O*

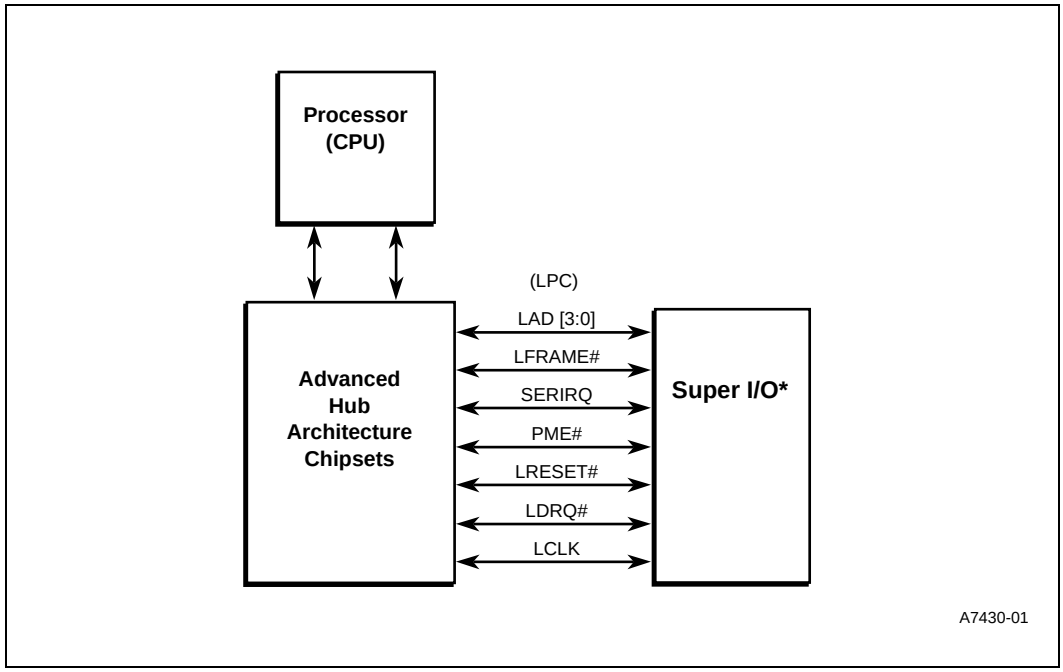
The Intel 840 chipset which is recommended for the performance platform connects to the Super I/O via a new interface called Low Pin Count (LPC) interface. A LPC solution enables Super I/O to be designed in an embedded platform without the need for a legacy ISA-bus or X-bus. This new LPC interface reduces the cost of traditional Super I/O because LPC Super I/O has lower pin count. LPC meets the data transfer rate of X-bus and exceeds those data where appropriate. In addition, it

increases the memory space from 16 Mbyte on the X-bus to 4 Gbtye to allow BIOS sizes to increase much greater than 1 Mbyte. Figure 2 shows the LPC interface between the chipset and the LPC Super I/O.

For more information on LPC, please refer to the *Low Pin Count Specification*, Revision 1.0 available at the following URL:

http://developer.intel.com/design/chipsets/industry/lpc.htm

Figure 2. Low Pin Count Interface



3.2.9 Legacy Support

In the performance platform for industrial PCs, the Intel 840 chipset does not provide an ISA interface. It provides 32-bit and 64-bit PCI and AGP interfaces, and four USB root ports for high performance I/O interfacing. The Low Pin Count (LPC) interface on the chipset supports LPC Super I/O devices. See Section 3.2.8, “Super I/O* or Ultra I/O*” on page 16 for more information about the LPC interface.

If an ISA bus is still required in the performance platform, the Intel 82380 can be used to provide a PCI-ISA bus interface. For more information, please refer to the following URL:

http://developer.intel.com/design/chipsets/mature/430TX/index.htm

3.2.10 Thermal Solutions

For thermal solutions for the Intel Pentium III processor in the FC-PGA package, refer to the *Intel® Pentium® III Processor Thermal Design Guide* (order number 273325).

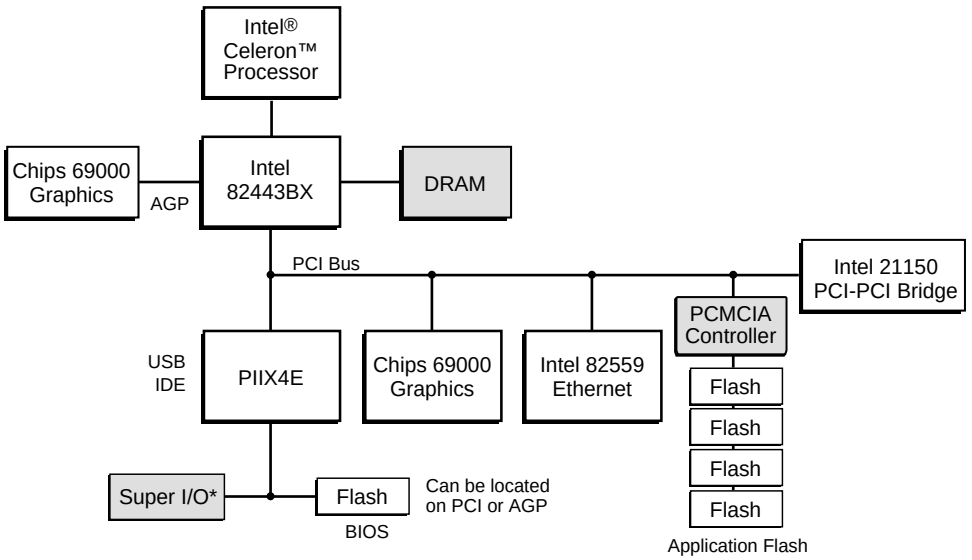
3.3 Industrial PC Value Platform Reference Configuration

Intel's value platform reference configuration for industrial PCs provides a fully optimized solution for this market segment. The Intel Celeron™ processor enables developers to provide higher performance while addressing today's value-driven market needs. It is available in a 370-pin PPGA socketable package that allows flexible and cost-effective designs. The Intel 440BX AGPset offers a cost-effective way to ensure that current designs will be ready for 100 MHz system bus implementations. The value platform reference configuration also provides cost effective and optimized graphics and networking solutions. In addition, the value platform offers safety in investment by providing embedded life cycle product support.

Table 2. Industrial PC Value Platform Reference Configuration

	Recommended Component	Packaging Type
CPU	Celeron™ processor at 566 MHz	Socketable 370-pin PPGA
Chipset	Intel® 440BX AGPset	Ball Grid Array
Graphics	Chips 69000	Ball Grid Array
LAN	Intel 82559	Ball Grid Array
Bridge	Intel 21150	PQFP
Flash	Intel Flash 1-8 Mbit	Various surface mount package

Figure 3. Industrial PC Value Segment Block Diagram



3.3.1 Processor and Chipset

The value industrial PC platform reference configuration emphasizes value with performance. Features include a high performance uni-processor and a socketable solution for scalability and flexibility. The recommended Intel processor for this reference configuration is the Intel Celeron processor.

The Intel 440BX AGPset optimizes the overall system performance of the Intel Celeron processor. It supports the emerging set of visual computing applications, including 3-D and video applications. Designing with the Intel 440BX AGPset is simplified because the chipset enables scalable board designs with either a 66-MHz or 100-MHz system bus. It supports an ISA bus for legacy devices, memory up to 1 Gbyte (registered DIMMs) and up to 5 PCI bus masters.

For more information on the Intel 440BX AGPset, please refer to the following URL:

http://developer.intel.com/design/chipsets/440bx/index.htm

3.3.2 Voltage Regulator

The voltage regulator module (VRM) supplies the required voltage and current to the processor. The voltage regulator module specification defines a range of DC-to-DC converters to meet the power requirements of the platform using Intel microprocessors.

For additional information, please refer to *VRM8.4 DC-DC Converter Design Guidelines* at the following URL:

http://developer.intel.com/design/PentiumIII/designgd/245335.htm

3.3.3 Clock Generators

Clock generators provide clocks to the processor, system logic, memory, and other on-board logic. For Intel architecture platform reference configurations, Intel has provided the clock synthesizer specification for clock vendors to ensure that future processor clock requirements are met.

For additional information, please refer to *CK98 Clock Synthesizer/Driver Design Guidelines* at the following URL:

http://developer.intel.com/design/PentiumIII/designgd/245338.htm

3.3.4 Memory

The value industrial PC platform reference configuration uses the PC100 SDRAM memory. The memory capacity for this platform is recommended to be up to 1 Gbyte in DIMMs. ECC optional but is supported in the value platform reference configuration.

3.3.5 Graphics

In the industrial PC value platform reference configuration, a highly integrated graphics controller should be implemented on board using either the Accelerated Graphics Port (AGP) Frame or the PCI bus. It must be able to support flat panel display and a display resolution of 1024 x 768 x 16bpp.

For the value industrial PC reference configuration, the recommended graphics controller is the highly integrated graphics/flat panel CHIPS 69000 controller. It has 2 Mbytes of embedded high speed SDRAM. By embedding SDRAM and graphics controller logic on the same die, the 69000 delivers uncompromised performance and consumes less power than the discrete solution. The integrated SDRAM supports up to 83 MHz operation, which provides up to 664 Mbytes/second frame buffer bandwidth. The increase in the frame buffer bandwidth enables the 69000 to support high-color, high-resolution graphics modes and real-time video acceleration. Key features of the 69000 include:

- **2-D acceleration for all modes**: The 69000 graphics engine enables high-performance systems. The 69000 boosts the 2-D performance through specialized hardware that accelerates the most frequently used 2-D GUI operations.
- **Versatile panel support**: The 69000 supports a wide variety of color and monochrome SS, DSTN, TFT, EL, and Plasma panels. Using HiQColor™ technology, the 69000 can display up to 16.7 M colors on passive DSTN panels. Up to 16.7 M colors can also be supported with 24-bit TFT panels.
- **Footprint/ package**: The 69000 is available in the 256-ball BGA or mini-BGA packages, which are suited for applications in which conserving PCB real estate is critical.
- **Flexible host bus support**: The 69000 provides a glueless interface for both PCI and Frame AGP host buses, which enable a wide range of platform applications.
- **Multimedia video**: The 69000 implements a variety of features to deliver high-quality, full-screen, full frame-rate video capture and playback for MPEG1, MPEG2, V-CD, and DVD.

For more information on the 69000, please refer to the following URL:

http://developer.intel.com/design/graphics/mobilgraphics/products/69000

3.3.6 Networking

The Intel 82559 and 82559ER Fast Ethernet Multifunction PCI Controllers are recommended for implementing the network interface for the industrial PC value platform reference configuration.

For more information on the 82559, please refer to Section 3.2.6, “Networking” on page 16 in the industrial PC performance platform section.

The Intel 82559ER is a fully integrated 10BASE-T/100BASE-TX LAN solution containing the Media Access Controller (MAC) and physical layer (PHY). It is a 32-bit PCI device that features enhanced scatter-gather bus mastering capabilities that enable the 82559ER to perform high speed data transfers over the PCI bus. The differences between 82559 and 82559ER are that 82559ER does not support the SMBus interface, Alert On LAN, and Wake on LAN. It is designed for low-power operation at 3.3 V.

For more information, please refer to the following URL:

http://developer.intel.com/design/network/82559er.htm

3.3.7 Bridges

PCI-to-PCI bridges for the value industrial PC platform reference configuration have 32-bit I/O interface. The Intel 21150 PCI-to-PCI bridge is recommended as PCI-to-PCI bridge for this reference configuration. The embedded PCI-to-PCI bridges are designed for compliance with the *PCI Local Bus Specification*, revisions 2.0 and 2.2. The bridge chips also comply with the Advanced Configuration Power Interface (ACPI) and Power Management Interface specifications. Products designed for compliance with *PCI Local Bus Specification*, revision 2.2, feature support for delayed transactions and have deeper buffers than do products that comply with revision 2.0. Standard bridges are used in many application types, including PCI slot expansion not possible without PCI-to-PCI bridges. Standard bridges are also used to increase the number of PCI devices on add-in cards or on-board.

For more information on the 21150, please refer to the following URL:

http://developer.intel.com/design/bridge/

3.3.8 Super I/O* or Ultra I/O*

Super I/O integrates several I/O devices that provide input and output ports for embedded platforms. Those ports are the mouse, keyboard, serial, and parallel port.

Please refer to Appendix B for a list of suppliers of Super I/O devices.

3.3.9 Thermal Solutions

Thermal design data for the Celeron processor at 566 MHz, as used in the industrial PC value platform reference configuration, is not available at the time of this writing. More information will be available in the future revision of this document. Contact your Intel representative to obtain the latest information.

The following list provides thermal design data for the Intel 440BX AGPset, which is used in the low-power industrial PC platform reference configuration:

Power dissipation:

- Maximum power dissipation is 7.3 W
- Minimum power dissipation is 4.8 W

Case temperature:

- No thermal enhancement is 105 °C
- Single processor system is 95 °C

Thermal solutions for the low-power industrial PC platform reference configuration:

- Heatsink form factor is 1.5” x 0.425”
- System fan form factor (recommended) is 3.15” sq. (80 mm), 40 CFM (~400 LFM)

3.4 Industrial PC Low-Power Platform Reference Configuration

Intel's low-power platform reference configuration for industrial PCs provides an optimized solution to addresses the needs of the low-power market segment. The Intel Pentium II Processor – Low-Power and Pentium III Processor – Low-Power are used in this reference configuration to provide high performance embedded computing with lower power consumption. The Pentium II Processor – Low-Power is available in a Ball Grid Array-1 (BGA1) package and the Pentium III Processor — Low-Power is available in a Ball Grid Array-2 (BGA2) package. These packages have a higher operating temperature suitable for robust industrial environments and provide a low-profile surface mount form factor. The Intel 440BX AGPset is optimized for Pentium II processor technology with enhanced power savings features. This reference configuration also provides optimized graphic and networking solutions to address the needs of this market segment. The PCI-to-PCI bridge provides reliable PCI support extension.

Note: Board re-spin is required when migrating from a BGA1 to a BGA2 package. For more information on the packaging differences, refer to the following URL:

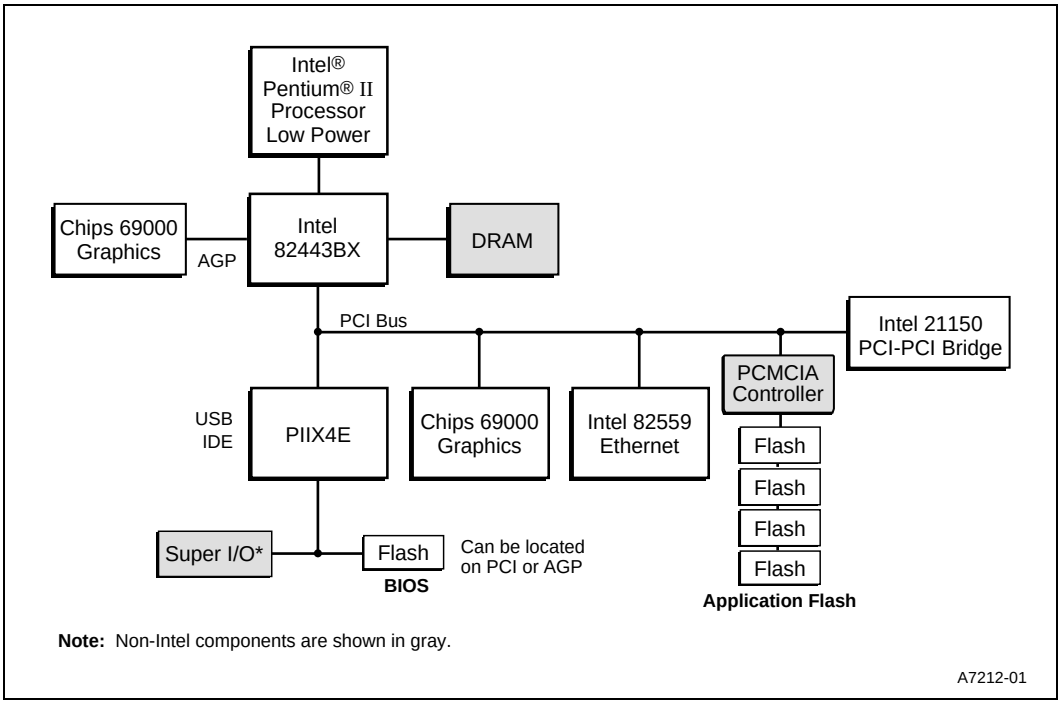
http://developer.intel.com/design/mobile/packdata/

Table 3 summarizes the components of the industrial PC low-power platform reference configuration.

Table 3. Industrial PC Low-Power Platform Reference Configuration

	Recommended component	Packaging Type
Processor	Pentium® II Processor – Low-Power at 333 MHz Pentium III Processor – Low-Power at 400 MHz	Ball Grid Array (BGA1) BGA2
Chipset	Intel® 440BX AGPset	Ball Grid Array
Graphics	Chips 69000	Ball Grid Array
LAN	Intel 82559	Ball Grid Array
Bridge	Intel 21150	PQFP
Flash	Intel Flash 1-8 Mbit	Various surface mount package

Figure 4. Industrial PC Low-Power Segment Block Diagram



3.4.1 Processor and Chipset

The low-power industrial PC reference platform reference configuration is optimized for low power consumption and management. It has the following features:

- High performance processor with low power consumption
- Low thermal envelope to avoid active-fan solutions
- Surface mount package (preferred due to space constrained systems).

The low-power reference configuration is designed to provide the best possible airflow for adequate thermal ventilation.

This reference configuration is designed to implement either the Intel Pentium II Processor – Low-Power or the Pentium III Processor – Low-Power .

The Pentium II Processor – Low-Power has the following key features.

- Operation at 333 MHz and front-side bus at 66 MHz
- Integrated 256 Kbyte L2 cache for optimum performance
- Surface mount low profile Ball Grid Array 1 (BGA1) package to support thin form factor designs

For more information on the Intel Pentium II Processor – Low-Power, refer to the following URL:

http://developer.intel.com/design/intarch/pentiumII/pentiumII.htm

The Pentium III Processor – Low-Power has the following key features.

- Operation at 400 MHz and 500 MHz with front-side bus at 100 MHz
- Integrated 256kbyte L2 cache
- Ball Grid Array 2 packaging which has 492 balls at 31mm x 27mm x 2.5mm

For more information on the Intel Pentium III Processor – Low-Power, refer to the following URL:

http://developer.intel.com/design/mobile/datashts/245302.htm

The chipset implemented on this reference configuration is the Intel 440BX AGPset. For more information on the Intel 440BX AGPset, please refer to the following URL:

http://developer.intel.com/design/chipsets/440bx/index.htm

3.4.2 Voltage Regulator

For voltage regulator information for the Pentium II – Low-Power and Pentium III – Low-Power processors, refer to *Intel Mobile Power Guidelines 2000* at the following URL:

http://developer.intel.com/design/mobile/intelpower/index.htm

3.4.3 Clock Generators

The low-power industrial PC platform reference configuration is designed for a 100 MHz or slower bus. For the Pentium II Processor – Low-Power, clock generators that comply with the CK97 Clock Synthesizer Design Guidelines are used. See the following URL for more information:

http://developer.intel.com/design/pentiumii/applnots/243867.htm

For the Pentium III Processor – Low-Power, clock generators that comply with the CK98 Clock Synthesizer/Driver Design Guidelines are used. See the following URL for more information:

http://developer.intel.com/design/PentiumIII/designgd/245338.htm

3.4.4 Memory

The industrial PC low-power platform reference configuration uses PC100 SDRAM memory.

The minimum memory capacity for this reference configuration is recommended to be 512 Kbyte in DIMM. ECC is optional for many applications within the low-power industrial PC market segment.

Note: For power conservation, the SDRAM signals CKE, SDA and SCL are connected to the CKE, SMBDATA and SMBCLK signals, respectively, of the Intel 440BX AGPset.

3.4.5 Graphics

In the low-power industrial PC platform reference configuration, a highly integrated graphics controller is recommended to be implemented on-board using either the Accelerated Graphics Port (AGP) Frame or PCI bus. It should be able to support flat panel display and a display resolution of 1024 x 768 x 16bpp.

The graphics controller implemented on this reference configuration is the CHIPS 69000. For more information on the 69000, refer to the Section 3.2.5, “Graphics” on page 15 in the value industrial PC platform section.

3.4.6 Networking

The Intel 82559 and 82559ER Fast Ethernet Multifunction PCI Controllers are recommended for implementing the network interface for the industrial PC low-power platform reference configuration.

For detailed information on the 82559, please refer to Section 3.2.6, “Networking” on page 16 in the performance industrial PC platform section.

The Intel 82559ER is a fully integrated 10BASE-T/100BASE-TX LAN solution containing the Media Access Controller (MAC) and physical layer (PHY). It is a 32-bit PCI device that features enhanced scatter-gather bus mastering capabilities that enable the 82559ER to perform high speed data transfers over the PCI bus. The differences between 82559 and 82559ER are that 82559ER does not support the SMBus interface, Alert On LAN, and Wake on LAN. It is designed for low power operation at 3.3 V.

For more information, please refer to the following URL:

http://developer.intel.com/design/network/82559er.htm

3.4.7 Bridges

Low power 3.3 V must be supported in this reference configuration.

For detailed information, please refer to Section 3.3.7, “Bridges” on page 21 in the value industrial PC platform section.

3.4.8 Super I/O* or Ultra I/O*

Super I/O integrates several I/O devices that provide input and output ports for embedded platforms. Those ports are the mouse, keyboard, serial, and parallel port.

Please refer to Appendix B for a list of suppliers of Super I/O devices.

3.4.9 Thermal Solutions

The following list provides thermal design data for the Pentium II Processor – Low-Power which is used in the low-power industrial PC platform reference configuration:

Maximum Power dissipation:

- At 266 MHz: 9.8 W
- At 333 MHz: 11.8 W

Heatsink technology:

- Extruded or Corrugated (Folded fin)

Fan technology:

- 5 V DC Brushless fan

Heatpipe technology:

- Groove type

Thermal attachment method:

- Clips, fasteners, screws

System Airflow:

- TBD

Height considerations for the thermal solution for this reference configuration are:

- Single-slot CPCI: 5.32 mm
- Double-slot CPCI: 24.1 mm
- 1U: 24.1 mm (depends on spacers and thickness of customer platform board)
- 2U: 48.2 mm (depends on spacers and thickness of customer platform board)

For more information, please refer to the *Pentium® II Processor – Low-Power Thermal Design Guide*, at the following URL:

http://developer.intel.com/design/intarch/applnots/273254.htm

The following list provides thermal design data for the 440BX AGPset, which is implemented in the low-power industrial PC platform reference configuration:

Power dissipation:

- Maximum power dissipation is 7.3 W
- Minimum power dissipation is 4.8 W

Case temperature:

- No thermal enhancement is 105 °C
- Single processor system is 95 °C

Thermal solutions for the industrial PC low-power platform reference configuration:

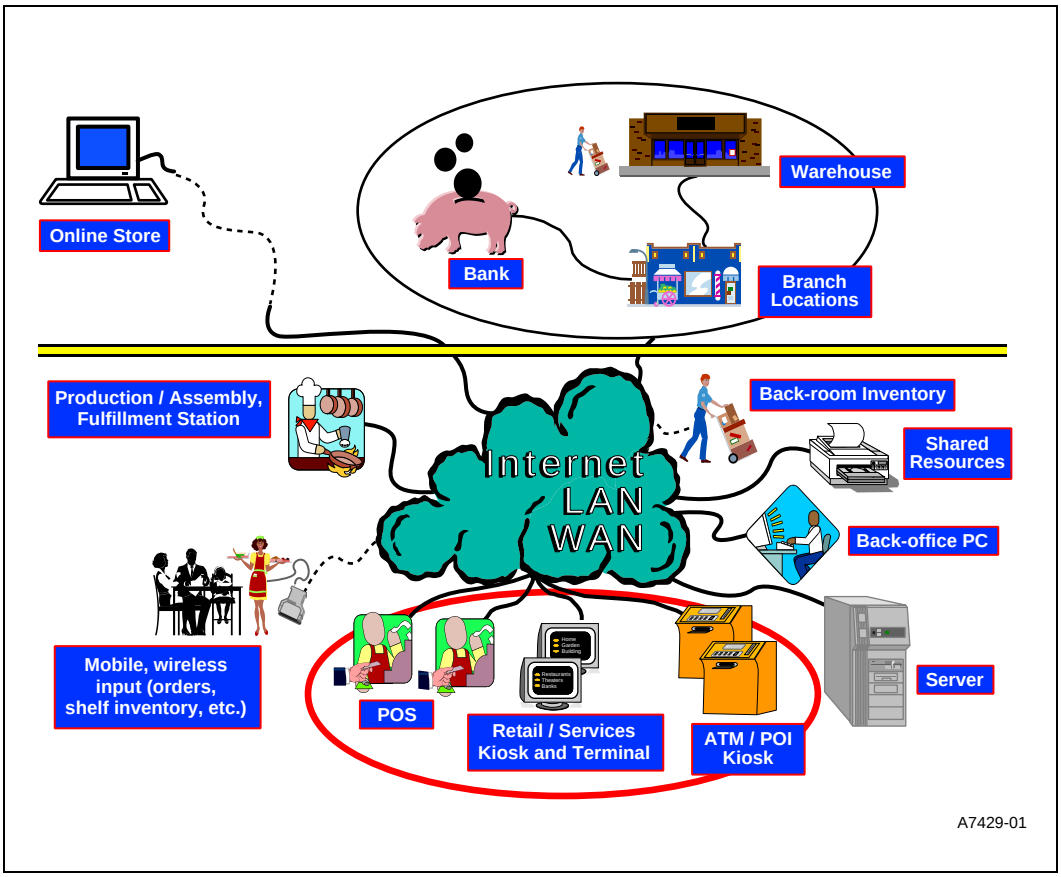
- Heatsink form factor is 1.5” x 0.425”
- System fan form factor (recommended) is 3.15” sq. (80 mm), 40 CFM (~400 LFM)

4.0 Transaction Terminal Solutions

4.1 Overview of Transaction Terminals

With increasing competition in the retail and financial industries, the ability to network transaction terminals is an extremely high priority. Networking provides the infrastructure for end customers, such as retailers, to achieve real time sales data collection and processing to better manage their business and optimize their operation. In many cases, the connectivity expands beyond the store fronts, back-room inventory, and production assembly to include linking with financial institutions, credit card processing centers, warehouses, online E-commerce services, and alliance stores.

Figure 5. Networking in Retail/Financial Industries



The retail transactional environment has traditionally been dominated with “dumb” terminals and mainframes. The transition to systems based on an open architecture and interface has been embraced by retailers to help reduce their total system cost, making the technology more affordable and widely available. The trend of moving from DOS-based to graphical user interfaces continues to drive the migration to standards-based systems such as Windows 95, 98, and NT, operating systems.

Transactional terminals require the price/performance to support demanding front-end applications, such as “commercial-ready” multimedia, extensive peripheral connectivity, and wireless and mobile devices. They also typically must have the ability to access the enterprise network through the Intranet or the Internet, connecting with Windows NT-based servers. Factors that are driving performance upgrades include the growing need to maintain a distributed database, loaded on the front end, and rich data type content such as video and high resolution graphics. In this market segment, biometrics technologies such as iris scanning, voice recognition, and fingerprint recognition are driving the need for higher performance processors.

Hardware has become commodity in embedded systems as it has in the PC industry. In many cases, transaction terminals are competing with desktop PCs. However, there are still values that OEMs provide in system partitioning and life cycle management. OEMs are starting to focus more on their value-added capabilities, such as providing versatile applications from independent software vendors (ISVs) or developed in-house, software, peripherals, E-commerce, Internet connectivity, data warehousing, and data mining.

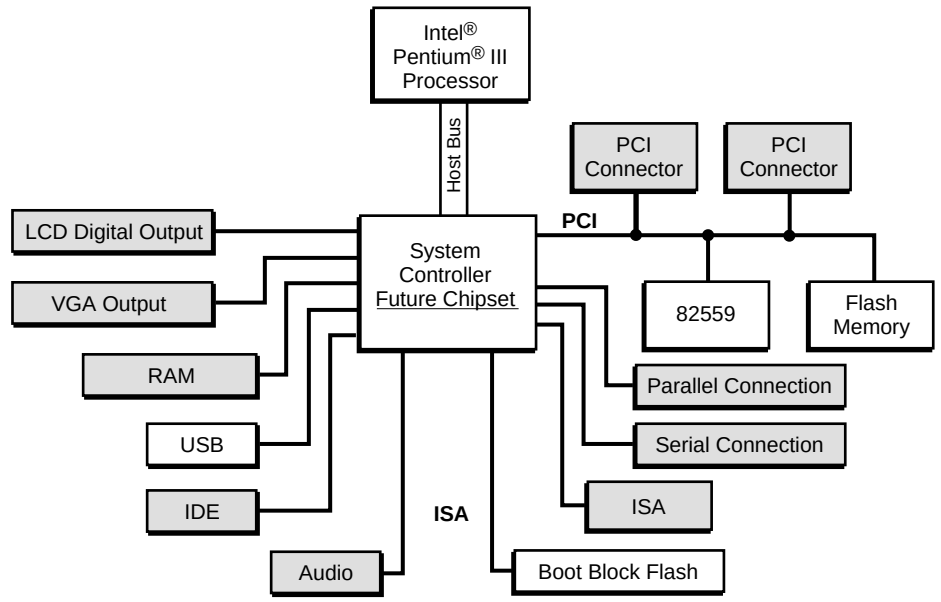
These trends represent an opportunity for embedded Intel architecture platform solutions to address the cost/performance, scalability, and portability requirements of these applications. The following sections discuss other devices in the transactional environment briefly, but focuses on Intel’s reference designs for PC-based point of sale terminals, point of interaction kiosks, and ATMs.

4.2 Transactional Terminal Performance Platform Reference Configuration

Intel's performance platform reference configuration for transaction terminals defines a platform suited to applications that require high performance to enable new management, customer interface, and graphic applications. Some of these applications require that the processor enable high performance desktop computing capability in the embedded market segment. This reference configuration provides an optimized solution that enables the benefits of latest PC technological innovation in the transactional terminal market segment while addressing the particular needs of embedded systems.

Figure 6 provides a high-level overview of the components of a transaction terminal design.

Figure 6. Transaction Terminal Performance Segment Block Diagram



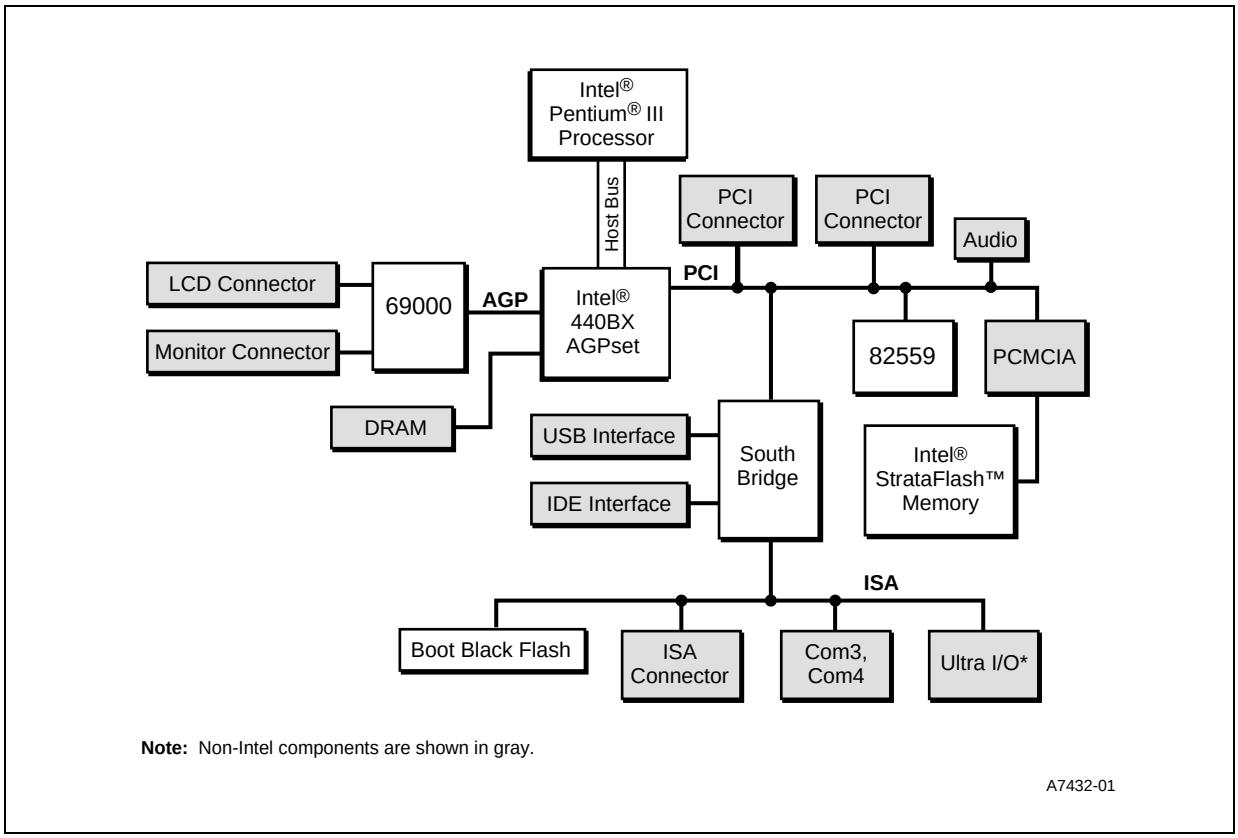
Note: Non-Intel components are shown in gray.

Table 4 identifies the components for a transaction terminal reference configuration using the Intel Pentium III processor and 440BX AGPset. Figure 7 illustrates this reference configuration.

Table 4. Transaction Terminal Performance Platform Reference Configuration

	Recommended Component	Packaging Type
CPU	Pentium® III processor at 600 MHz	Flip Chip - Pin Grid Array (FC-PGA)
Chipset	Intel® 440BX AGPset	Ball Grid Array
Graphics	Chips 69030	Ball Grid Array
LAN	Intel 82559	Ball Grid Array
Flash	Intel Flash 1-8 Mbit	Various surface mount package

Figure 7. Transaction Terminal Performance Segment Block Diagram for the Intel® 440BX AGPset



4.3 Transactional Terminal Value Platform Reference Configuration

Intel's value platform reference configuration for transaction terminals provides a fully optimized solution for applications that require performance at the right price. The management applications are the same as the performance segment, but the graphic capabilities are less. The Intel Celeron processor enables developers to meet higher performance requirements while addressing today's value-driven market needs. The Intel 440BX AGPset offers a cost-effective way to ensure that current designs will be ready for 100 MHz system bus implementations. This reference configuration provides cost-effective and optimized graphics and networking solutions. It also provides safety in investment by providing embedded life cycle product support. Value segment applications typically require a cost-effective solution for the system interface (bridge). The value segment reference design will migrate to the Intel 810 chipset solution.

Table 5. Transaction Terminals Value Platform Reference Configuration

	Recommended Component	Packaging Type
CPU	Celeron™ processor at 566 MHz	Socket 370 PGA
Chipset	Intel® 440BX AGPset Intel 810 chipset	Ball Grid Array
Graphics	Chips 69000	Ball Grid Array
LAN	Intel 82559	Ball Grid Array
Flash	Intel Flash 1-8 Mbit	Various surface mount package

Figure 8 illustrates the components of the transaction terminal value configuration using the Intel 810 chipset, and Figure 9 illustrates the reference configuration using the Intel 440BX AGPset.

Figure 8. Transactional Terminal Value Segment Block Diagram for the Intel® 810 Chipset

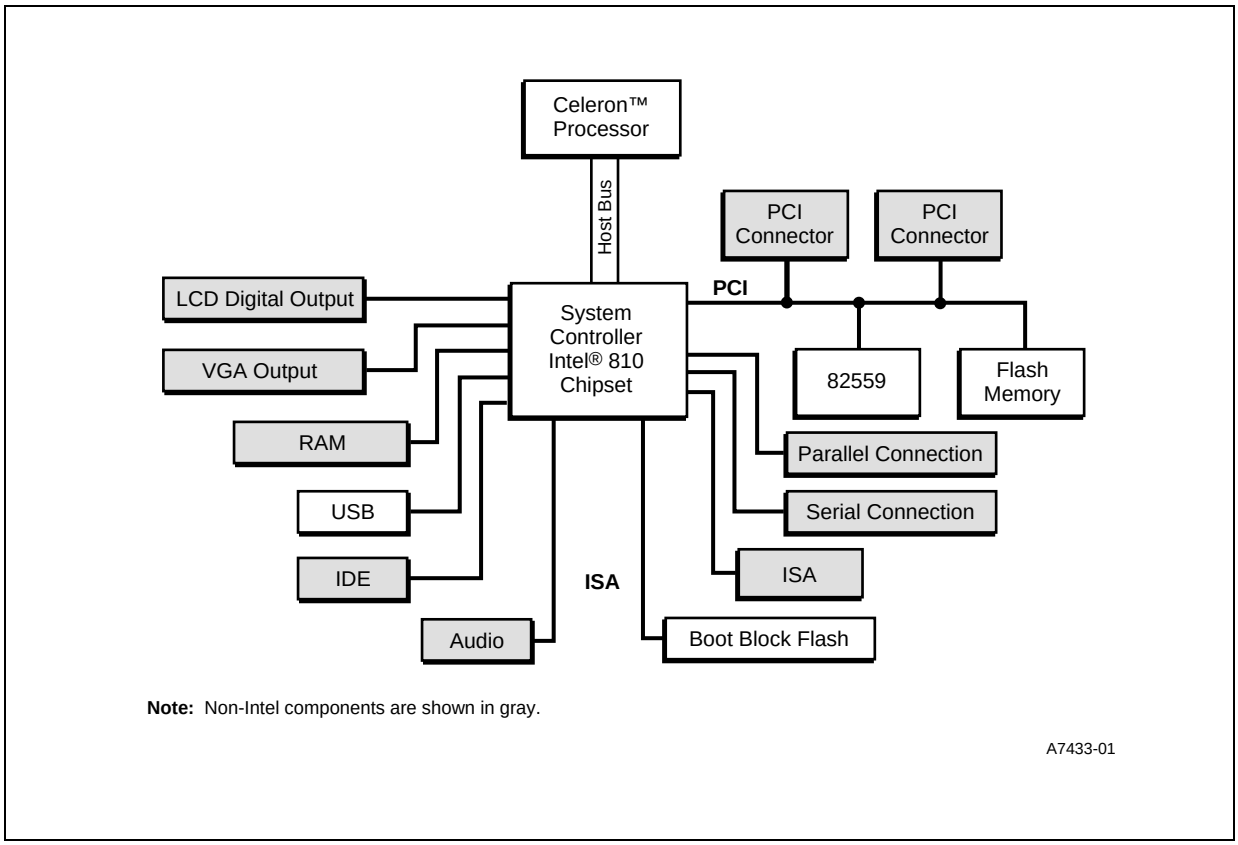
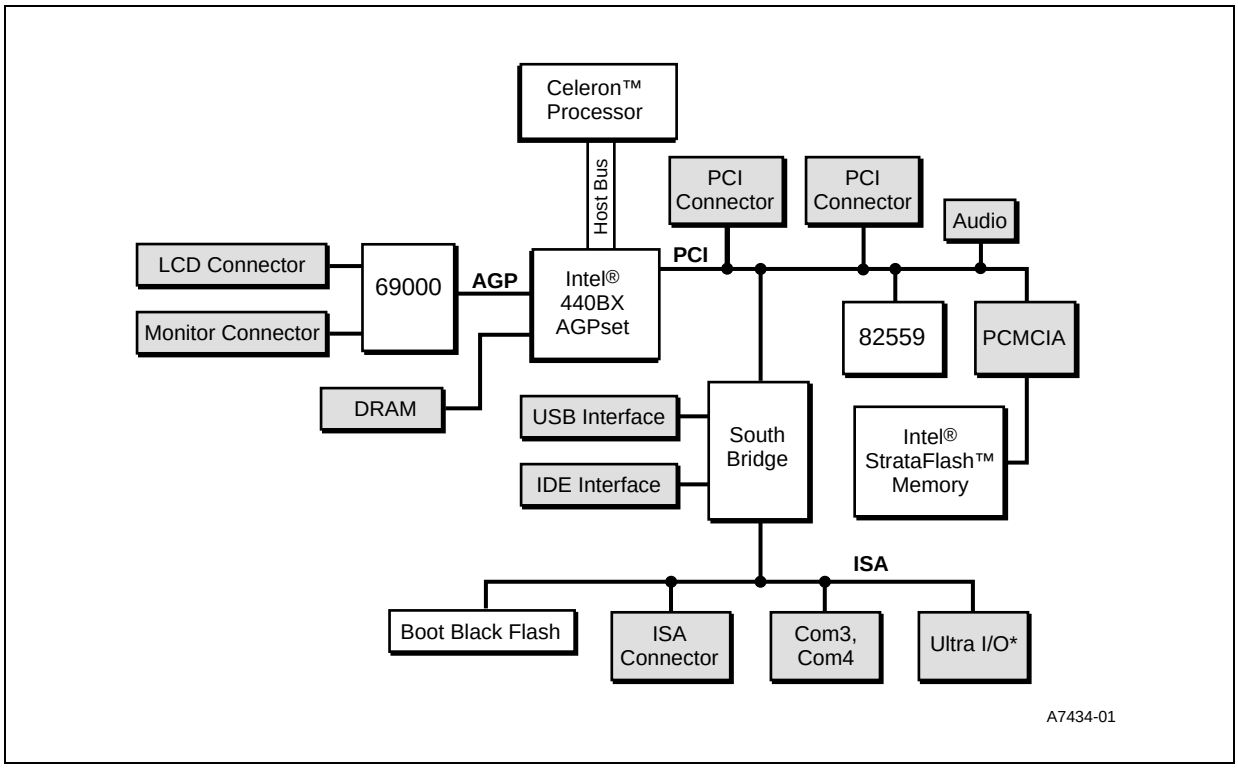


Figure 9. Transactional Terminal Value Segment Block Diagram for the Intel 440BX AGPset



4.4 Transactional Terminal Low-Power Platform Reference Configuration

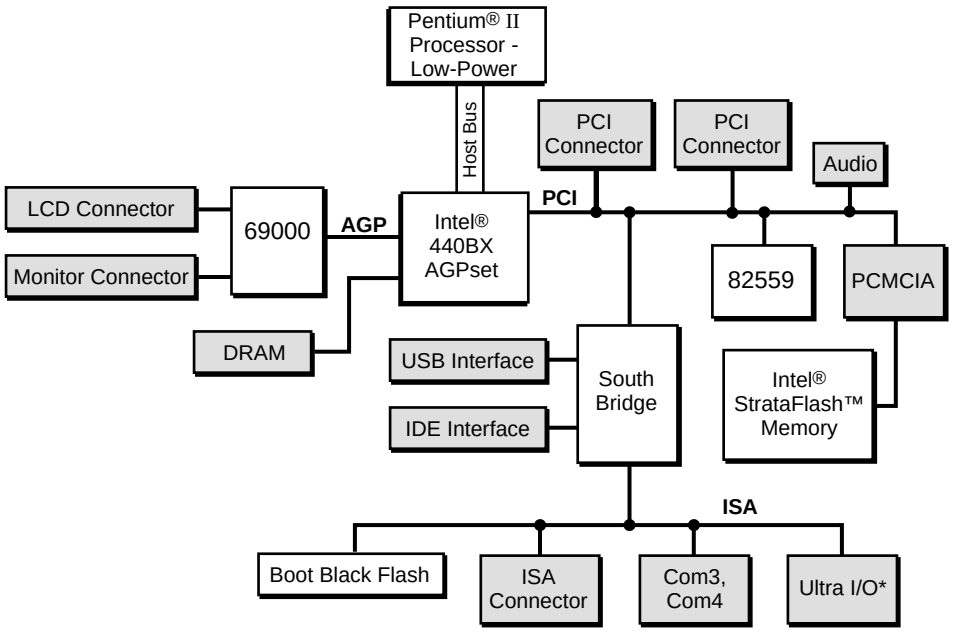
Intel's low-power platform reference configuration for transaction terminals provides an optimized solution for applications that require low power dissipation. The Pentium II Processor – Low-Power used in this reference configuration provides high performance embedded computing with lower power consumption. It is available in a Ball Grid Array package, which allows a higher operating temperature suitable for robust industrial environment, and provides a low profile surface mount form factor. The Intel 440BX AGPset is optimized for Pentium II processor technology with enhanced power savings features. This reference configuration also provides optimized graphic and networking solutions that meet the needs of low-power transaction terminal applications.

Table 6. Transaction Terminal Low-Power Platform Reference Configuration

	Recommended Component	**Packaging Type**
CPU	Pentium II Processor – Low-Power at 333 MHz Pentium III Processor – Low-Power at 400 MHz	Ball Grid Array
Chipset	Intel® 440BX AGPset	Ball Grid Array
Graphics	Chips 69000	Ball Grid Array
LAN	Intel 82559	Ball Grid Array
Flash	Intel Flash 1-8 Mbit	Various surface mount package

See Figure 10 for a block diagram of the transaction terminal low-power reference configuration using the Pentium II Processor – Low-Power.

Figure 10. Transactional Terminal Low-Power Segment Block Diagram for the Intel 440BX AGPset



Note: Non-Intel components are shown in gray.

A7434-01

5.0 Key Initiatives for Intel® Architecture-based Platforms

5.1 Wired for Management

Wired for Management (WfM) is an Intel initiative to improve the manageability of desktop, mobile and server systems. The Wired for Management (WfM) initiative is an Intel-led, industry-supported effort to make Intel architecture-based systems universally manageable and universally managed, without sacrificing agility or performance. Through the WfM initiative, Intel has worked with others in the industry to develop guidelines for a new generation of platforms that can be centrally managed over networks to reduce Total Cost of Ownership (TCO). Systems based on these guidelines provide key technologies that, combined with management software applications, deliver capabilities that enable “down-the-wire management” and benefits in four critical areas of managing and controlling the computing environment:

- Asset Management
- Service Boot (Remote New System Setup)
- Off-hours Maintenance (Remote Wake-up)
- Reduced Power Consumption

For more information on the WfM initiative, refer to the following URL:

http://developer.intel.com/ial/wfm/

6.0 Software Considerations

6.1 Operating Systems

Operating systems that are commonly used in the industrial PC and transaction terminal market segments include Windows-based operating systems and real time operating systems (RTOS). Windows NT and Windows CE both support Intel architecture designs, and many RTOSs also provide support for Intel architecture.

6.1.1 Windows NT

Windows NT has commonly been used for desktops applications, but both the Windows NT Workstation and NT Server are now being used in embedded systems, including the following:

- ATM
- Industrial automation
- Point-of-sales terminals
- Computer telephony
- Kiosks
- Data & telecommunications

The Windows NT application programmer interface, WIN32, provides the robustness required in all dedicated applications as well as the server functionality. Windows NT drivers are available for Intel architecture platform components.

6.1.2 Windows CE

Windows CE is a 32-bit multitasking, multithreaded operating system for embedded systems. Windows CE is a fully ROMable operating system that features pre-emptive multitasking, integrated power management, a Windows-like GUI, and a standard communication protocol that facilitates Internet access and information sharing with other Windows applications.

Windows CE systems can be equipped with a broad range of I/O facilities, so the software requirements will vary from one application to the next. For example, systems that use flash memory for storing Windows CE and application code may integrate software that enables the flash memory to emulate a hard drive (examples include TrueFFS* from M-Systems.). The device drivers needed depend upon the hardware needs. The Intel platform reference configurations include an 82559 driver and display driver (69000 and 69030) for Windows CE.

Windows CE supports PCI and bridges in Intel architecture platforms. Windows CE does not currently support multiprocessor systems.

A USB driver was developed for Windows CE to support the Intel USB UHCI chipset. Drivers have also been developed to provide Windows CE support for IDE hard disk drives and Boot Flash File Systems in Intel architecture platforms.

Windows CE does not utilize a standard PC BIOS. These facilities are implemented through the Object Abstraction Layer (OAL) and platform-specific drivers. An OAL driver was developed to support the Windows CE hardware abstraction layer so that Windows CE can run on top of Intel architecture systems.

6.1.3 Real Time Operating Systems

Many of the Real Time Operating Systems (RTOS) in the market provide support for Intel architecture platforms. One of the main concerns in choosing an RTOS is the availability of device driver support.

Intel 82559 drivers will be available for a number of RTOSs (VxWorks*, Linux*, and QNX*) for embedded Intel architecture customers who use the Intel 82559 Ethernet controller on their network-enabled products.

An Intel 69000 driver for VxWorks and Linux will be available to support customers who use the Intel 69000 graphics controllers in their applied computing products.

Intel also provides a Gigabit Ethernet driver to support an Intel Gigabit Ethernet controller in the VxWorks OS environment.

6.2 BIOS and Initialization Code Issues

The BIOS is responsible for booting the computer by providing a basic set of instructions. It performs all the tasks needed at start-up time: POST (Power-On Self Test), booting an operating system from FDD, HDD OR CDROM. It also provides an interface to the underlying hardware for the operating system in the form of a library of interrupt handlers. When an operating system such as Windows needs data or information about system hardware, it uses a BIOS routine to communicate with it. An RTOS, however, does not need the BIOS to communicate with the hardware; with appropriate driver support, the RTOS can access the hardware directly.

Because many applied computing platforms do not have all of the functions of a standard PC, such as a keyboard, display monitor, floppy disk, or hard disk, the BIOS firmware can be customized for the specific platform. For this purpose, the Intel reference configurations provide some reference code for a minimal BIOS that customers can customize to suit their application.

DOS legacy operating systems typically require a BIOS to perform legacy functions such as POST, initialization, and OS interaction. Due to the complexity of chipsets and processors, and the fast pace of technological innovation in PC-derived products, a BIOS is often used in legacy-based embedded systems for lack of a timely, validated, and configurable boot/initialization code suite.

Some embedded operating systems, however, including VxWorks, Linux, QNX, Windows CE and others, may have no historical dependency on a BIOS. The OS vendor or the microprocessor vendor often provides a POST/boot/initialize code suite that the OEM can customize and integrate to perform BIOS-equivalent functions.

7.0 Tools

This section describes hardware tools, software tools, and software libraries available for Intel architecture platforms.

7.1 Hardware Development Tools

Table 7 is a list of development tools use for the performance, value, and low-power industrial PC and transaction terminal platform reference configurations.

Table 7. Development Tools for Industrial PC and Transaction Terminal Platform Reference Configurations

Tool Type	Vendor	Tool Name/Description
Logic Analyzer	• Hewlett-Packard Company	• Logic Analysis Systems (model: 16600A, 16700A and 16702A)
	• Tektronix, Inc.	• TLA 700 Series Logic Analyzer
Emulator	• American Arium • Applied Microsystems	• In-Target-Probe (ITP) Emulators • Full Featured In-Circuit Emulators (Only American Arium)
PCI Bus Tool	• FuturePlus Systems Corp.	• PCI Bus Analysis Probes for HP Logic Analyzers
	• Hewlett Packard Company	• HP E2925A 33MHz, 32-bit PCI Exerciser & Analyzer • HP E2926A 33MHz, 32/64-bit PCI Exerciser & Analyzer • HP E2927A 50/66MHz 32/64-bit PCI Exerciser & Analyzer • HP E2972A PCI Performance Analyzer s/w • HP E2974A PC Sub-system Stress Test s/w • HP E2975A PCI Protocol Permutator & Randomizer
Board Testers	• International Test Technologies	• MT2000 Microprocessor Broad Test & Repair System • Full scan capability
Rambus Impedance Probe	• HP	• HP54750A & 54754A/TDR Scope
Logic Analyzer Add-in module for Rambus	• HP • Tektroniz	• FSI-60033/FSI-60034/Rambus Analysis Probe • TMS810-RAMBUS Direct Support

7.2 Windows 9x, Windows NT Software Development Tools/ Libraries

7.2.1 VTune™ Performance Analyzer 4.0

Developing highly optimized applications requires developing code that takes complete advantage of the latest Intel processor technology. Intel provides the VTune™ Performance Analyzer solution for developers of high-performance software for all Intel processors. The VTune Performance Analyzer collects, analyzes, and provides Intel architecture-specific software performance data from the system-wide view down to a specific module, function, or instruction in your code. Supported programming languages are C/C++, Java*, FORTRAN, and assembly language.

For more information, please refer to the following URL:

http://developer.intel.com/vtune/analyzer/

7.2.2 Intel® Performance Library Suite

The Intel Performance Library Suite currently includes the five libraries listed below.

- Signal Processing Library

  The Intel Signal Processing Library provides a set of signal processing functions for the Intel architecture processors similar to those available for most Digital Signal Processors (DSPs).

- Recognition Primitives Library

  The Intel Recognition Primitives Library provides developers of speech- and character-recognition software with a set of recognition primitives optimized for Intel architecture.

- Image Processing Library

  The Intel Image Processing Library provides a set of low-level image manipulation functions in standard DLLs and static libraries form. The functions are optimized for Intel architecture processors and are particularly effective at taking advantage of MMX technology.

- JPEG Library

  The Intel JPEG Library provides high-performance encoding and decoding of full-color and grayscale continuous-tone still images in JPEG format.

- Math Kernel Library

  The Intel Math Kernel Library provides developers of scientific and engineering software with a set of linear algebra and fast Fourier transform functions as a static library optimized for the Intel architecture.

For more information, please refer to the following URL:

http://developer.intel.com/vtune/perflibst/

7.2.3 Wired for Management Development Tools

The Wired for Management site provides information about several tools to aid in developing and testing manageability of the product.

For more information, please refer to the following URL:

http://developer.intel.com/ial/wfm/tools/

7.2.4 Intel® Performance Evaluation and Analysis Kit

Intel's IPEAK is a family of platform performance and integration tools. The IPEAK is comprised of seven tools for optimizing various components of the industrial PC and transaction terminal reference platforms as described below. For an OEM, independent hardware vendor, or independent software vendor, the IPEAK tools help to optimize designing products based on the transaction terminal/industrial PC platform reference configurations.

- WDM IO Monitoring Tool (IOMon)

  The Intel WDM I/O Subsystem Performance Monitor (IOMon) is a software tool that enables the tester to verify both the functionality and performance of their hardware devices and device drivers. This is accomplished by monitoring all I/O Request Packets (IRPs) through the WDM driver stack.

- Graphics Performance Tool (GPT)

  The Graphics Performance Tool (GPT) provides an integrated GUI environment for analyzing graphics hardware and software performance on the Intel architecture platform. It includes hardware performance analysis, software performance analysis, workload/scene analysis, and API analysis. The tool uses Direct3D* and supports the workload/scene analysis of other APIs through standardized data formats.

- Intel Baseline AGP System Evaluation Suite

  The Intel Baseline AGP System Evaluation Suite (IBASES), provides a collection of tools that evaluate AGP performance for optimum hardware and software integration. The individual tools evaluate the driver and adapter for AGP texturing volume and throughput, functionally test this combination for support of AGP capabilities through DirectX*5.0, and monitor application utilization of AGP, as well as traditional local video memory.

- Power Management Analysis Tool

  The Intel Power Management Analysis Tool (IPMAT) helps in the evaluation and qualification of systems that support the Advanced Configuration and Power Interface (ACPI). IPMAT can be used for vendor selection and qualification by checking for, and exercising the ACPI power management support of hardware, devices, and drivers.

- Storage Performance Toolkit

  Storage Toolkit is designed to aid in the performance improvement and selection of storage devices. It includes the capability to manipulate and analyze system-level disk I/O traces, rank drive performance, and perform low-level drive performance analysis.

- DVD Qualification & Integration Tool

  DQUIK is a software tool that aids in the building of systems that include DVD, specifically host-based DVD playback. This tool looks at all components which interact for DVD playback, such as audio, graphics, and video, and reports back on whether the platform is optimized.

- 1394 Toolkit

  The 1394 Toolkit is a software suite which lets you monitor performance and verify the operational stability of your 1394 PC drivers, system bus, and peripherals.

For more information, please refer to the following URL:

http://developer.intel.com/design/ipeak/

7.2.5 Compilers

7.2.5.1 Intel® C/C++ Compiler

The Intel C/C++ Compiler is compatible with Microsoft Visual C++* and can be used as a plug-in to the Microsoft Visual Studio*. Refer to Table 7 for a list of features and benefits for using the Intel C/C++ compiler.

Table 8. Features and Benefits of Using the Intel® C/C++ Compiler

Features	Benefits
Compatible with source code developed with the Microsoft* Visual Studio* Visual C++ versions 4.2, 5.0, and 6.0.	Allows developers to directly port software already developed in Microsoft Visual Studio to the Intel compiler.
Provide Streaming SIMD Extensions and MMX™ technology C++ class libraries.	Allows developers to use a very high-level interface to these newest features of Intel processors.
Supports Streaming SIMD Extensions and MMX technology through the use of C “intrinsics”.	Allows developers to use call syntax of C functions instead of manually coding in assembly language.
Provides vectorization optimizations.	Allows the compiler to exploit parallel instruction capability.
Provides profile-guided optimization (PGO).	Allows the compiler to adjust the flow of the program to achieve enhanced performance based on previous executions with the same data set.

For more information, please refer to the following URL:

http://developer.intel.com/vtune/icl/

7.2.5.2 Third Party Vendor C/C++ Compilers

Third party vendors of C/C++ include:

- Cynus
- GNU
- CADUL
- Thomson Software Products

7.3 Real Time Operating System Development Tools

RTOS development tools include:

- VxWorks RTOS from Wind River system. See the following URL: http://www.wrs.com/corporate/html/software.html
- QNX RTOS from QNX Software System. See the following URL: http://www.qnx.com/intel/

For the latest development tool list, see the following URL:

http://developer.intel.com/design/tpvsolutions/software.htm

Appendix A Related Resources

For all component documentation, including datasheets, application notes and design guides for the Pentium® III, Pentium II, and Celeron™ processors, please visit the "Embedded Intel Architecture for Applied Computing" website at the following URL:

http://developer.intel.com/design/intarch/

For additional information on Intel's applied computing platform solutions, please visit the following website:

http://intel.com/platforms/applied/

Also refer to the following documents for related design information:

Table 9. Related Resources

Document Title	Order Number	URL
PC 99 System Design Guide	–	http://developer.intel.com/design/desguide/
Easier to Use Consumer PCs in 1999 - Hardware Implementation Guide	–	http://developer.intel.com/technology/easeofuse/EZPC-09.htm
LAN On Motherboard (LOM) Design Guide application note (AP-392)	718213	http://developer.intel.com/design/network/applnots/718213.htm
Intel® 82559 Printed Circuit Board Design (AP-399)	739073	http://developer.intel.com/design/network/applnots/739073.htm
Alert On LAN Design Guide Application Note (AP-388)	703222	http://developer.intel.com/design/network/applnots/703222.htm
Low Pin Count Specification, Revision 1.0	–	http://developer.intel.com/design/chipsets/industry/lpc.htm
VRM8.2 DC-DC Converter Design Guidelines	243773	http://developer.intel.com/design/PentiumII/xeon/designgd/243773.htm
VRM8.4 DC-DC Converter Design Guidelines	243773	http://developer.intel.com/design/PentiumIII/designgd/245335.htm
CK97 Clock Synthesizer Design Guidelines	243867	http://developer.intel.com/design/PentiumII/applnots/243867.htm
CK98 Clock Synthesizer/Driver Design Guidelines	245338	http://developer.intel.com/design/PentiumIII/designgd/245338.htm
Pentium® II Processor – Low-Power Thermal Design Guide	273254	http://developer.intel.com/design/intarch/applnots/273254.htm
Intel® Pentium® III Processor Thermal Design Guide	273325	http://developer.intel.com/design/intarch/applnots/273325.htm

Appendix B List of Components and Suppliers

The table below list components that may be included on the Industrial PC and Transaction Terminal platform reference configurations.

Table 10. Non-Intel Components and Vendors for the Industrial PC and Transaction Terminal Platform Reference Configuration (Sheet 1 of 3)

Manufacturer	URL
PCI-to-ISA Bridges	
Standard Microsystems Corporation	http://www.smsc.com/main/catalog/slc88b17.html
Integrated Technology Express, Inc	http://www.iteusa.com
Super I/O	
Standard Microsystems Corporation	http://www.smsc.com/
Integrated Technology Express, Inc	http://www.iteusa.com
National Semiconductor Corporation	http://www.national.com
Clock Generators	
Cypress Clock Generators	http://www.cypress.com
American Microsystems	http://www.amis.com/trans/
Fairchild Semiconductor	http://www.fairchildsemi.com
Integrated Circuit Systems, Inc.	http://www.icst.com/products/
IC Works	http://www.icworks.com/products/pc-cpu/
International Microcircuits, Inc	http://www.imicorp.com/products/pindex.htm
Pericom	http://www.pericom.com/products/sclock/index.html
Texas Instruments	http://www.ti.com/sc/docs/products/logic/index.htm
Motorola	http://www.motorola-asia.com/semiconductors.htm
PhaseLink Laboratories	http://www.phaselink.com/Products/products.htm
Philips Semiconductor	http://www-eu3.semiconductors.com/products/
Voltage Regulators	
Celestica	http://www.celestica.com/cfm/products/power.html
Delta Electronics Products Corp.	http://www.deltaca.com/product/products.htm
Lite-On	http://www.vishay-liteon.com/products/index.htm
VXI Electronics	http://www.vxie.com/products.html
RIMM connector	
Molex	http://www.molex.com/news/rambus/rambus.html
Berg Electronics	http://www.bergelect.com

Table 10. Non-Intel Components and Vendors for the Industrial PC and Transaction Terminal Platform Reference Configuration (Sheet 2 of 3)

Manufacturer	URL
LVDS connector	
Molex	http://www.molex.com
Berg Electronics	http://www.bergelect.com
DIMM connector	
Molex	http://www.molex.com/product/sockets/sockets.htm#dimm
Berg Electronics	http://catalog.berg.com/scripts/berg.exe?RT=SS&FAM=SOD
Heatsink	
Aavid Thermal Products, Inc.	http://www.aavid.com/atp/datashts.html
Johnson Matthey Electronics	
AVC (Taiwan)	http://www.avc.com.tw/pnew.htm
ADDA Corporation	http://www.adda.com.tw/02pro.html
Global WIN Technology	http://www.globalwin.com.tw/English/Home.htm
Foxconn (USA)	http://www.foxconn.com/catalog/computer.htm
Cooler Master Co. Ltd	http://www.coolermaster.co.uk/
Nidec Corporation	http://www.nidec.com/fans.html
Sumitomo Precision Products Co., Ltd.	http://www.spp.co.jp/English/jigyou/jigyou-e.html
Thermalloy, Inc	http://www.thermalloy.com/html/products/heatsinks.html
Fan	
Panasonic Industrial Co.	http://www.maco.panasonic.co.jp
Sanyo Denki America, Inc.	http://www.sanyodenkiamerica.com
Sunonwealth Electric Machine Industry Co., Ltd	http://www.sunon.com.tw/index_en.html
Heatpipe	
Fujikura America, Inc.	http://www.fujikara.com/product.html
Furukawa Electric	http://www.furukawa.co.jp/english/products.htm
Thermacore, Inc.	http://www.thermacore.com
370 Pin PGA Connector	
AMP Incorporated	http://amp.com/product/1mm
Foxcom (USA)	http://www.foxconn.com/catalog/index.asp?REGION=PROCESSOR

Table 10. Non-Intel Components and Vendors for the Industrial PC and Transaction Terminal Platform Reference Configuration (Sheet 3 of 3)

Manufacturer	URL
Power Silicon	
Analog Devices	http://products.analog.com/products_html/list_gen_category_tree.html
Cherry Semiconductor	http://www.cherrysemiconductor.com/cgi-bin/php36.cgi/products2.html
Fairchild Semiconductor	http://www.fairchildsemi.com/products/
Intersil Corp. (Harris)	http://www.intersil.com/
International Rectifier	http://www.irf.com/product-info/
Linear Technology	http://www.linear.com/cgi-bin/database?function=elementinhtml&filename=DataSheet.html&name=DataSheet&num=86
LinFinity	http://www.linfinity.com/prod-ps.htm
Maxim	http://209.1.238.249/pl_list_maker.cfm
Semtech	http://www.semtech.com/html/products.html
Siliconix	http://www.siliconix.com/www/menus/products.htm
STMicroelectronics	http://us.st.com/stonline/products/selector/index.htm
Texas Instruments	http://www.ti.com/sc/docs/schome.htm
Unisem	http://www.unisem.com/
Unitrode	http://www.unitrode.com/products/products.htm

Appendix C Intel® Celeron™ Processor / Intel 440BX AGPset Schematic

The following schematics are for the Intel Celeron processor and Intel 440BX AGPset. To obtain the latest schematics for other platforms and components mentioned in this document, please refer to the following URL:

http://www.intel.com/design/intarch/schems/

Celeron™ 66/100MHz FSB Processor Based Industrial PC Reference Schematic

** Please note that these schematics are subject to change.

Table of Contents

Revision History

February/2000 Revision 1.0 -- Initial release

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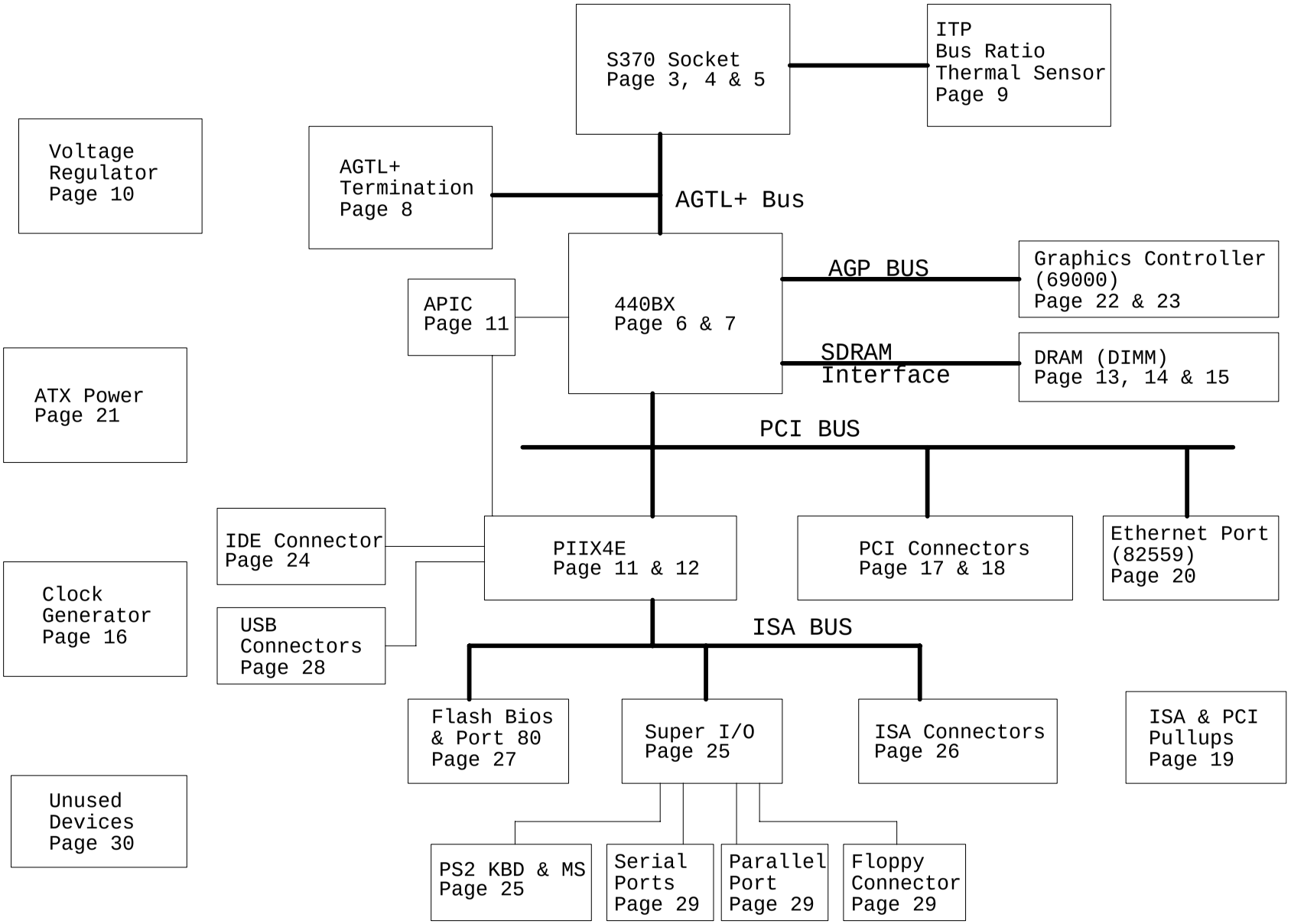
Title: Celeron (TM) 66/100 MHz FSB Processor Based Industrial PC Reference Design

Size: C | Document Number | Rev: 1.0

Date: Tuesday, February 01, 2000 | Sheet 1 of 30



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Intel Corporation

Title: Celeron (TM) Processor Based Industrial PC Reference Design Block Diagram

Size: C | Document Number | Rev: A3

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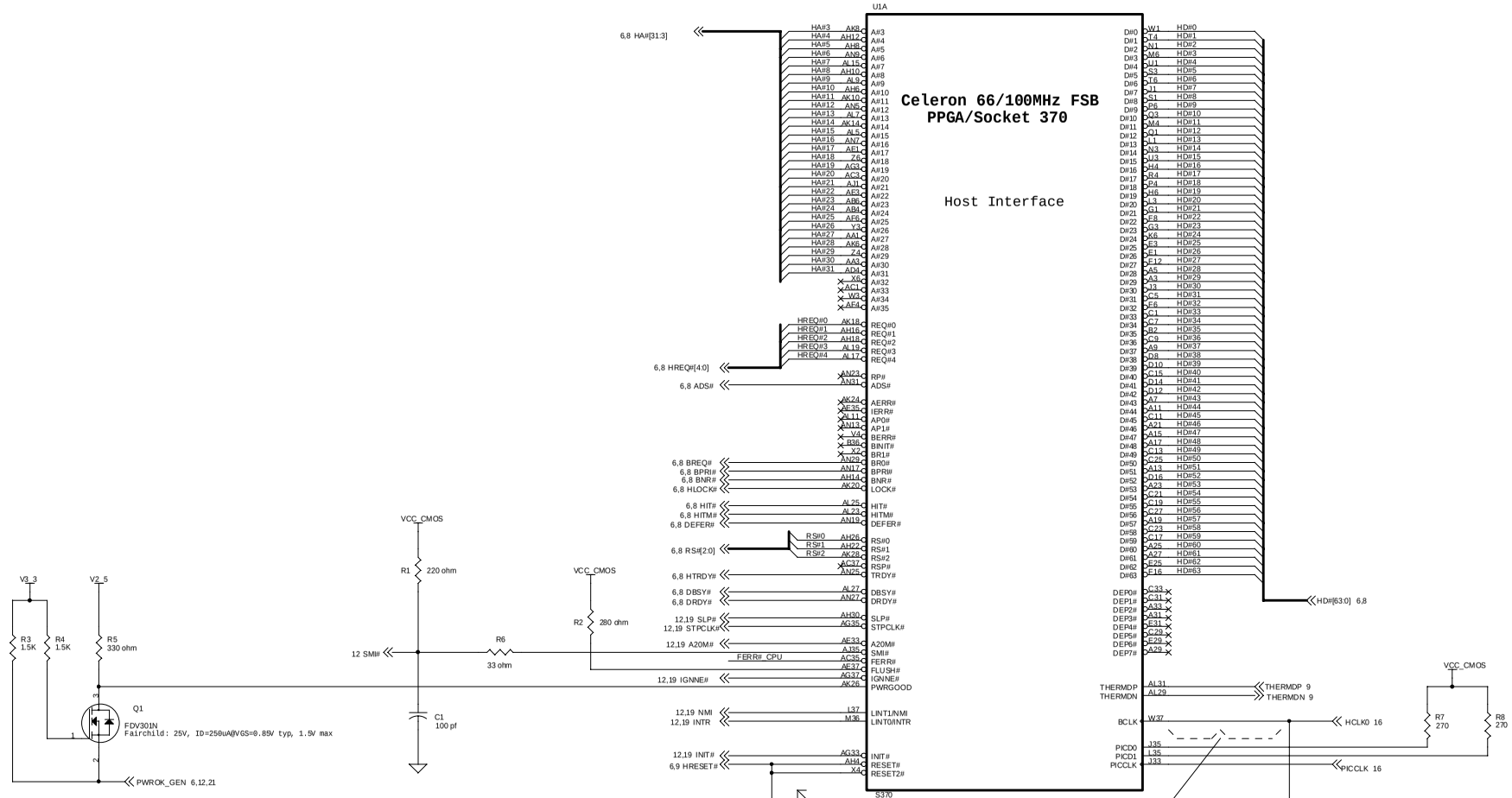
>>LAYOUT: Silkscreen. Put CPU pin numbers on both top and bottom layers.



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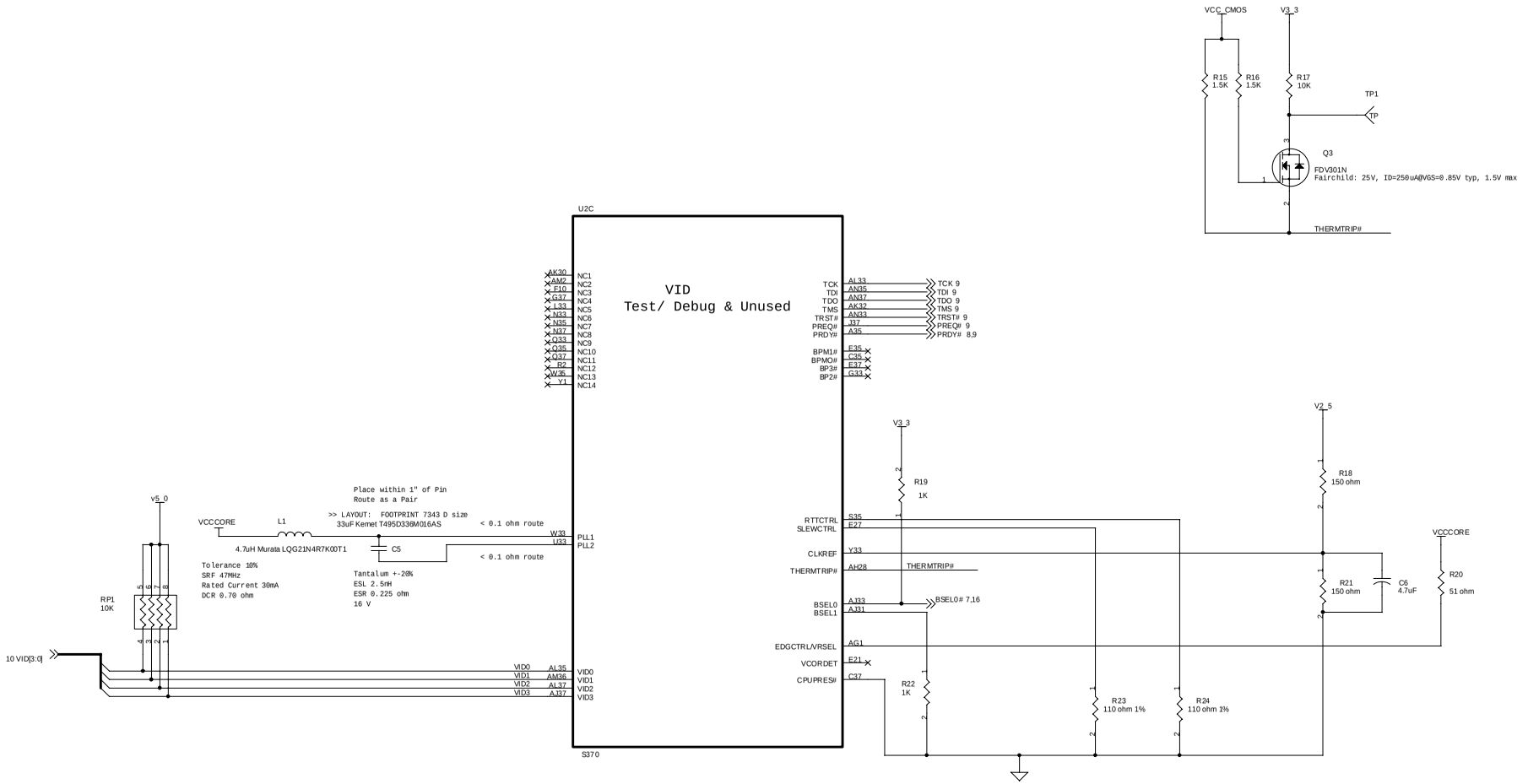
Title: 370 Host Interface

Size: C | Document Number | Rev: A3

Date: Tuesday, February 01, 2000 | Sheet 3 of 30



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Title	370 VID_Test_Debug	
Size C	Document Number	Rev A3
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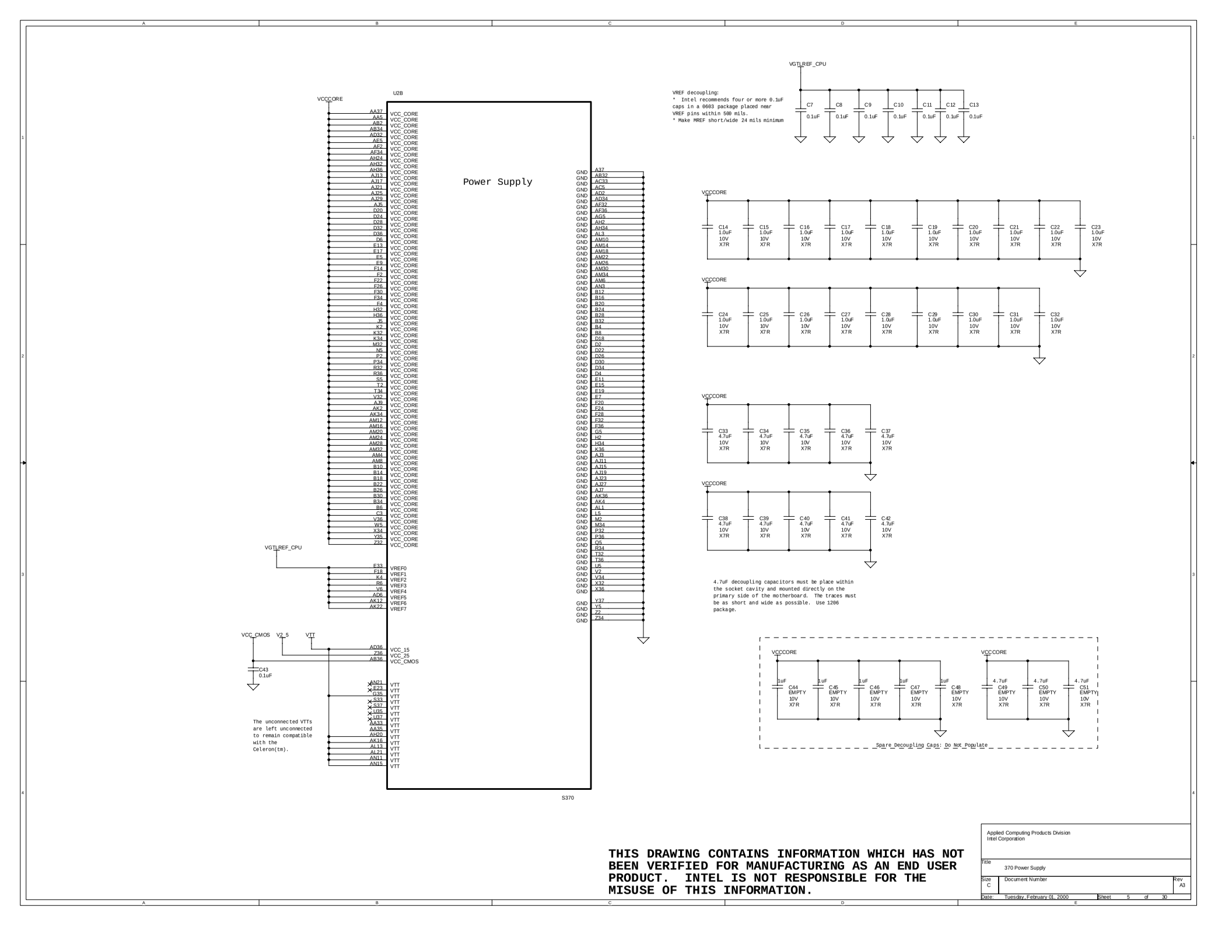

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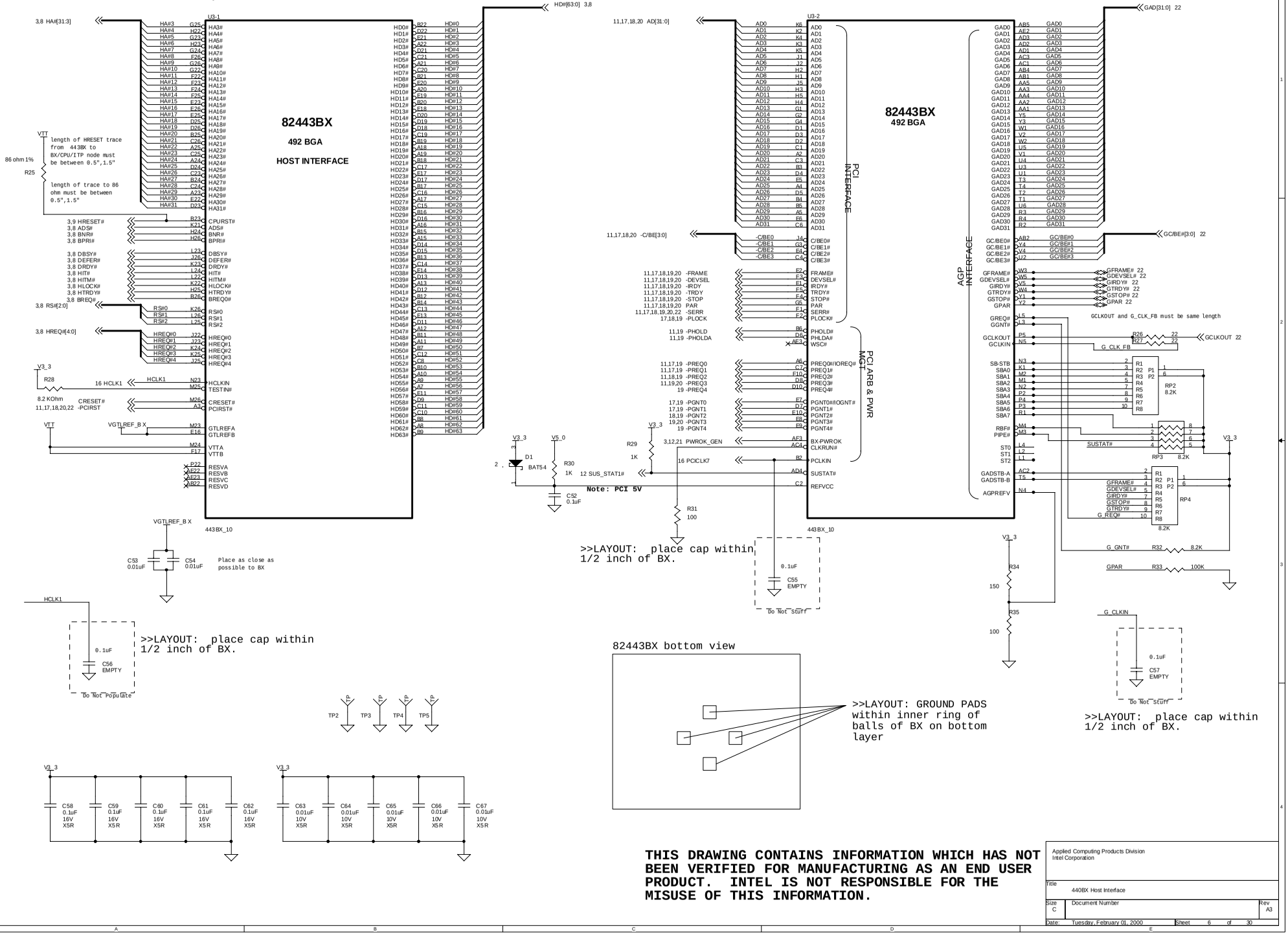
Title	370 Power Supply	
Size C	Document Number	Rev A3
Date: Tuesday, February 01, 2000	Sheet 5 of 30	

>>LAYOUT: Silkscreen. Put 82443BX pin numbers on both top and bottom layers.



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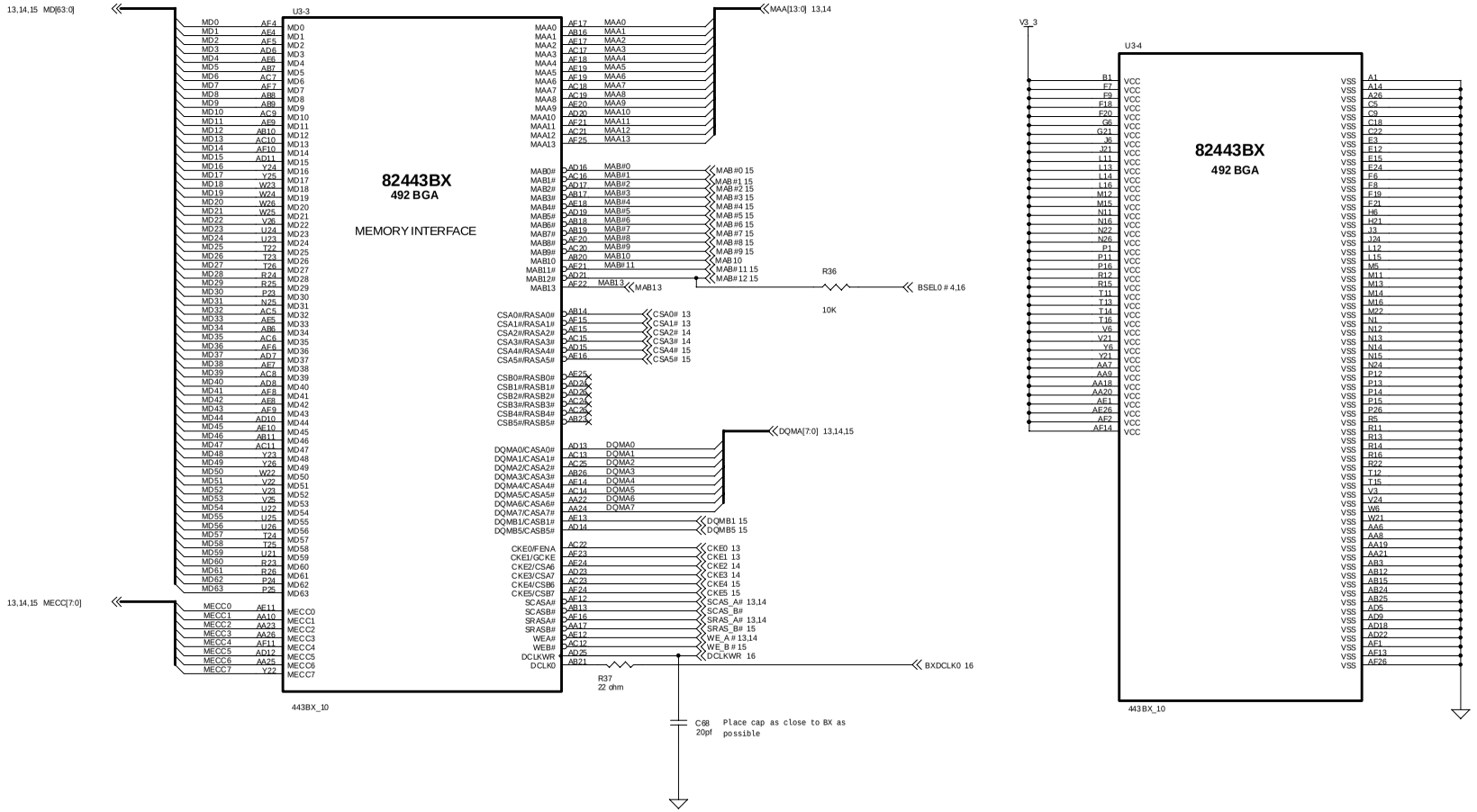
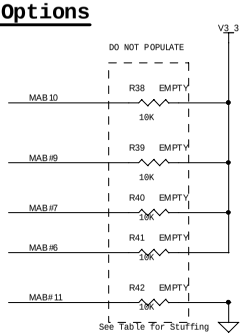
Applied Computing Products Division Intel Corporation	
Title	440BX Host Inteface
Size: C	Document Number
Rev: A3	
Date: Tuesday, February 01, 2000	Sheet 6 of 30



BX Strapping Options

Resistor	Function	Board Default Setting	Signal
R21	Quick Start Select	Do Not Stuff	MAB10#
R22	AGP Disable	Do Not Stuff	MAB9#
R23	Memory Module Configuration	Do Not Stuff	MAB7#
R24	Host Bus Buffer Mode Select	Do Not Stuff	MAB6#
R25	In-Order Queue Depth Enable.	Do Not Stuff	MAB11#



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Intel Corporation

Title: 440BX Memory Interface

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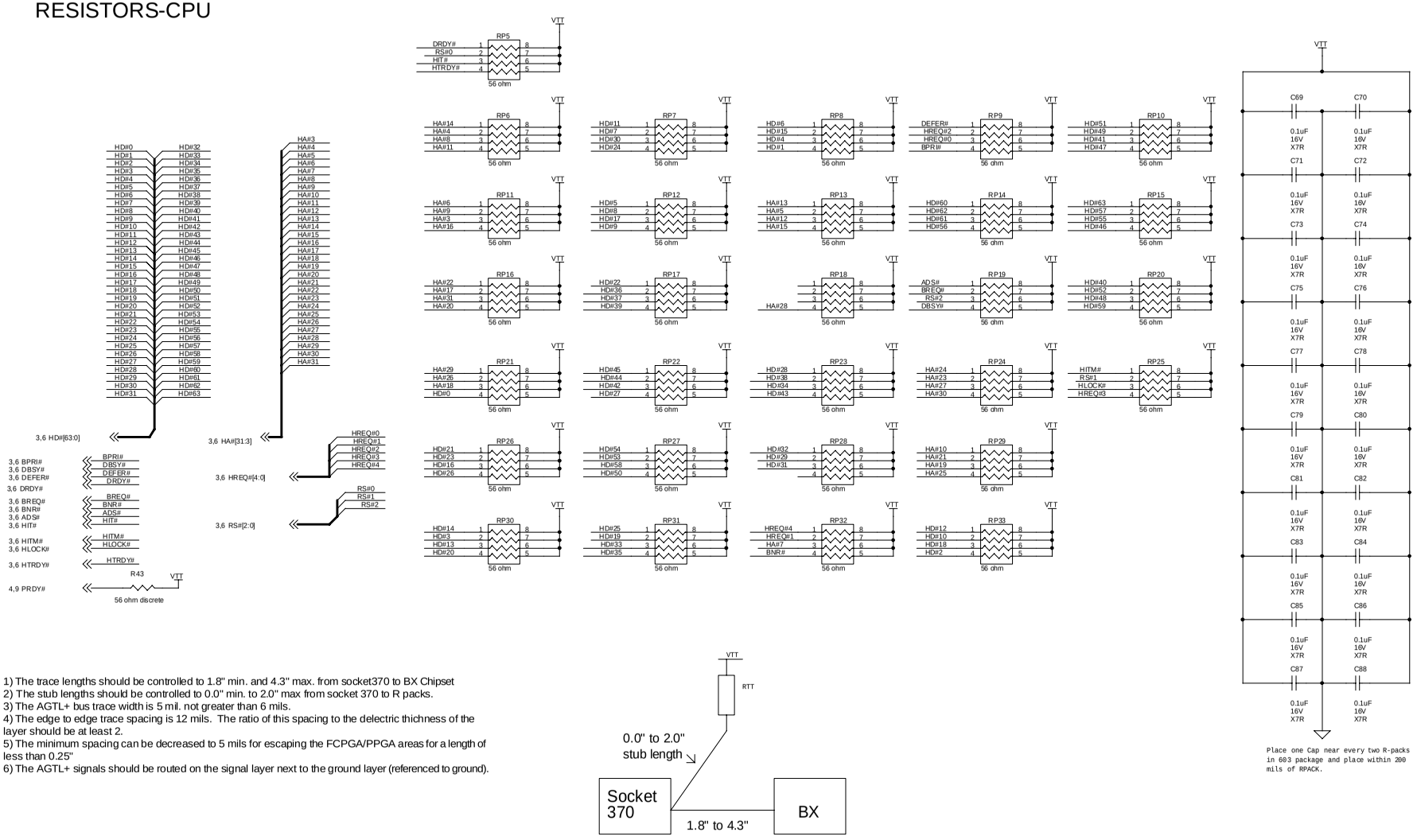
GTL+ TERMINATION RESISTORS-CPU



1) The trace lengths should be controlled to 1.8" min. and 4.3" max. from socket370 to BX Chipset
2) The stub lengths should be controlled to 0.0" min. to 2.0" max from socket 370 to R packs.
3) The AGTL+ bus trace width is 5 mil. not greater than 6 mils.
4) The edge to edge trace spacing is 12 mils. The ratio of this spacing to the delectric thichness of the layer should be at least 2.
5) The minimum spacing can be decreased to 5 mils for escaping the FCPGA/PPGA areas for a length of less than 0.25"
6) The AGTL+ signals should be routed on the signal layer next to the ground layer (referenced to ground).

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Title: GTL+ Termination

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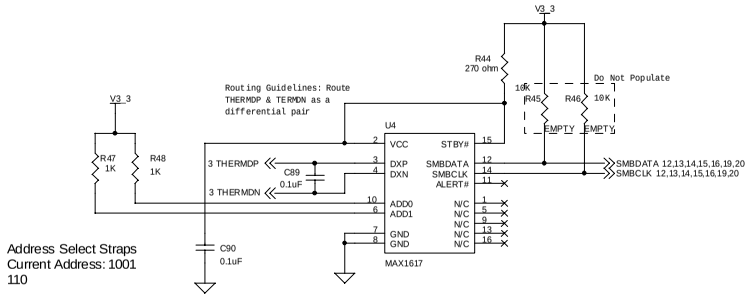
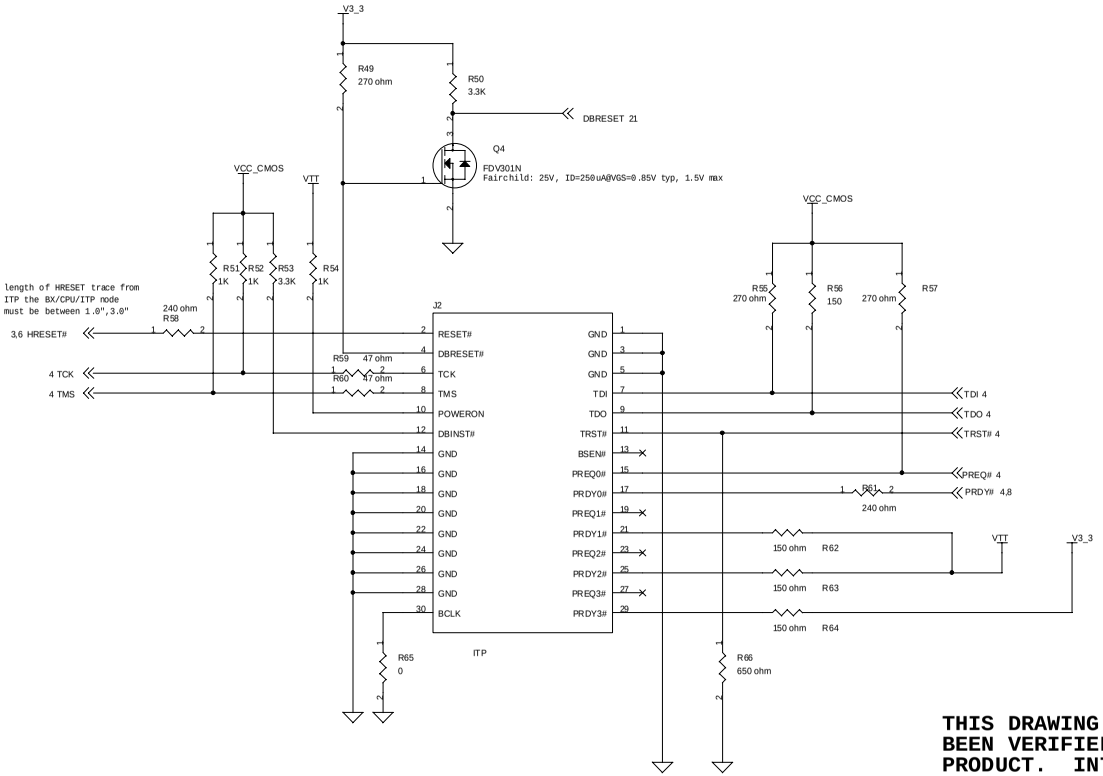
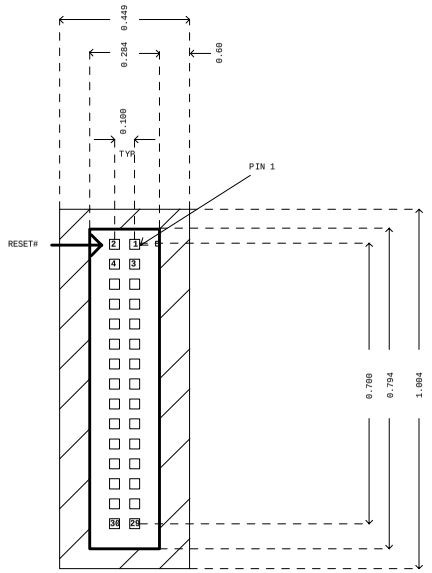


Address Select Straps
Current Address: 1001
110

THERMAL SENSOR





>>> LAYOUT
1.5V connector, AMP 104078-4 Vertical Recepticle, Top View
of ITP connector with component keep-out area.

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Title: ITP, Bus Ratio and Thermal Sensor

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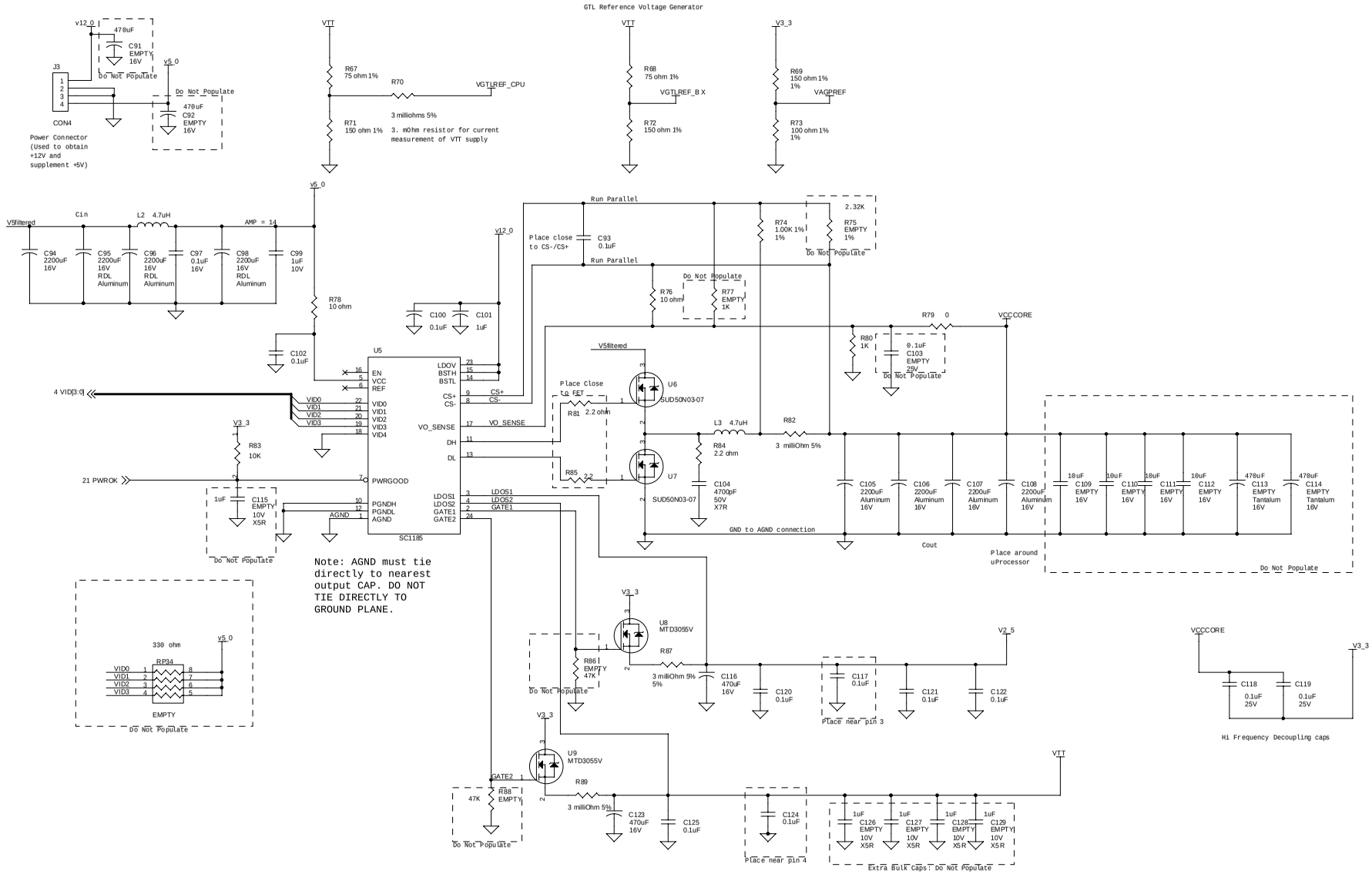

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Title	Voltage Regulator
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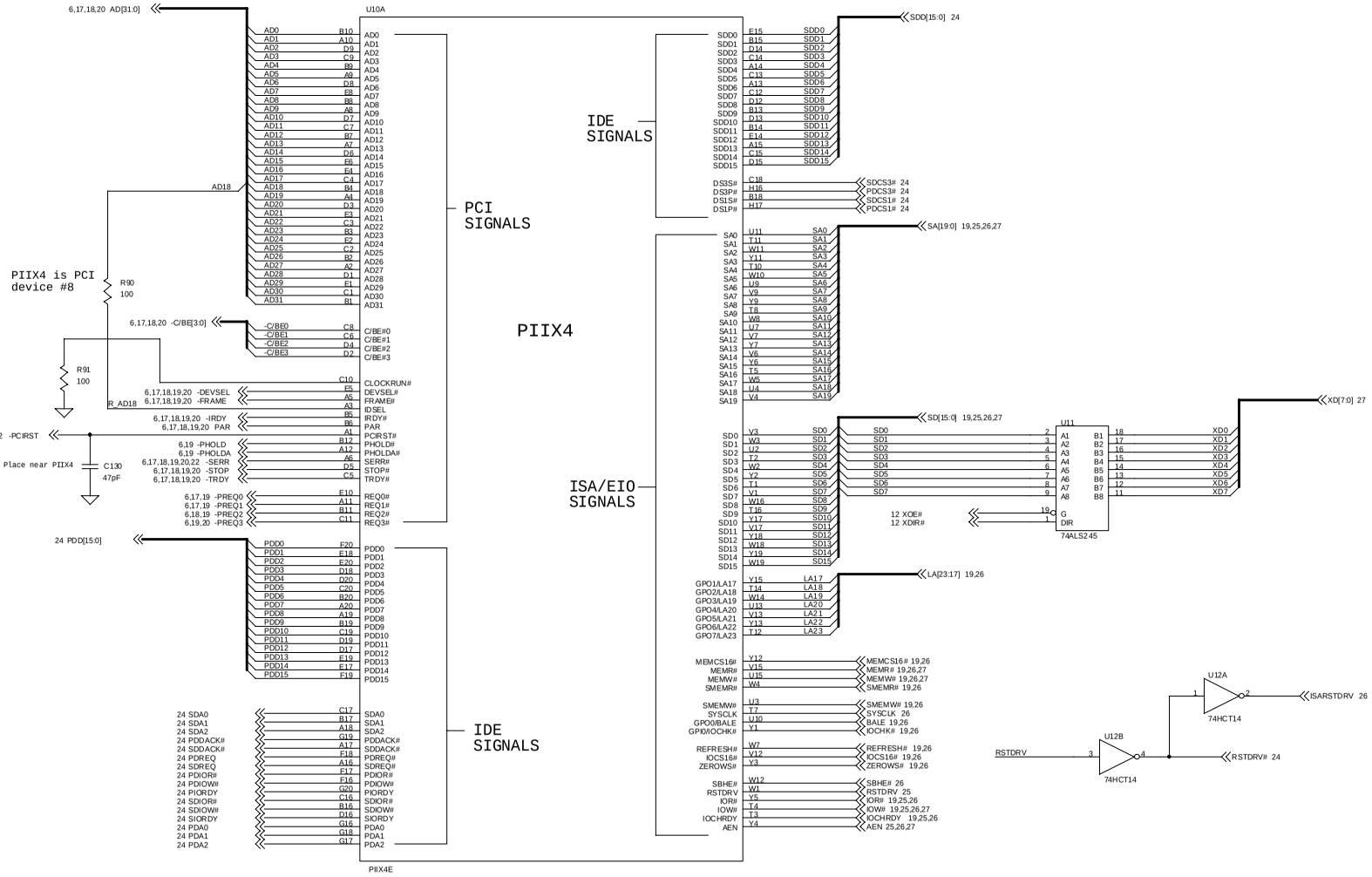

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Title: PIIX4E Part 1

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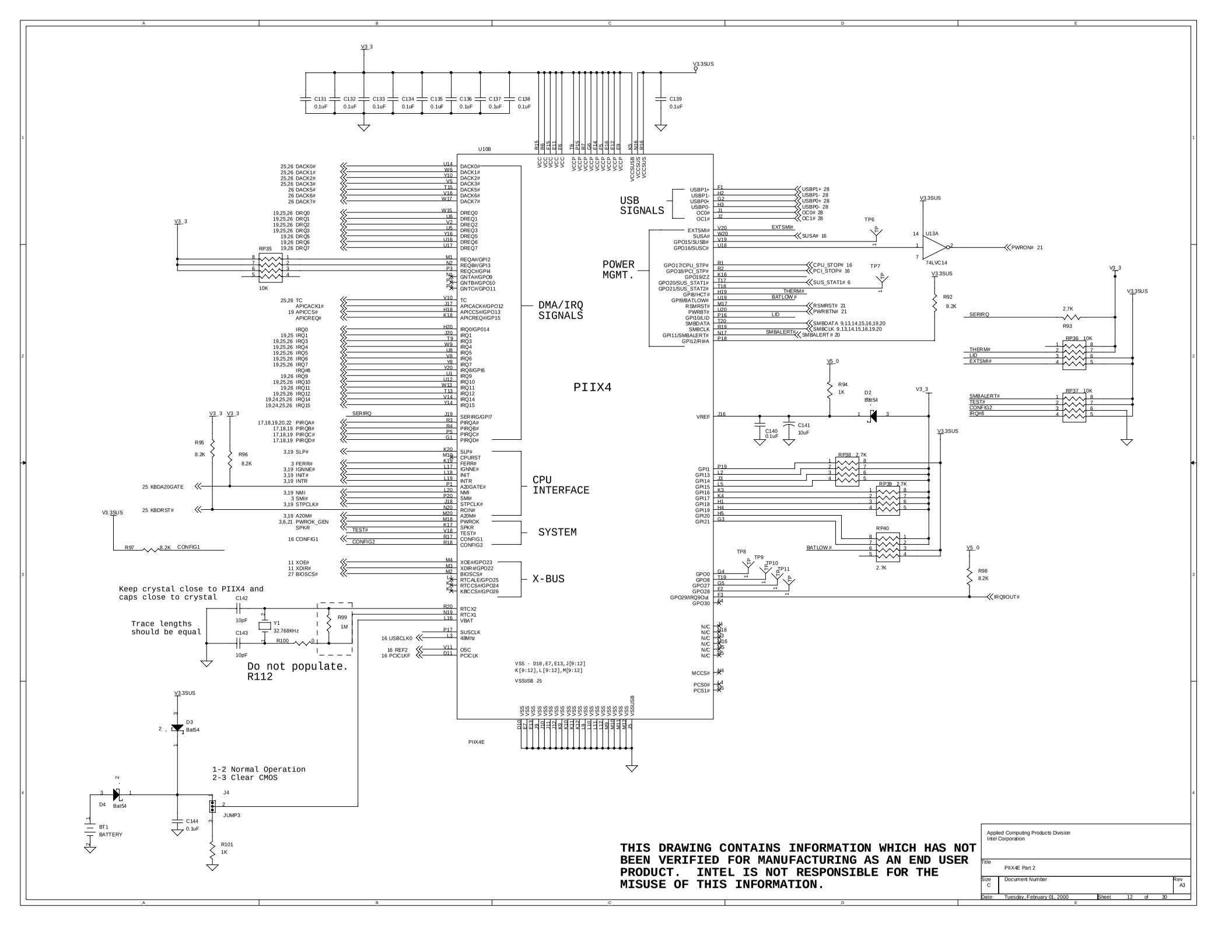
V3_3
V3.3SUS
C131 0.1uF
C132 0.1uF
C133 0.1uF
C134 0.1uF
C135 0.1uF
C136 0.1uF
C137 0.1uF
C138 0.1uF
C139 0.1uF
U10B
DMA/IRQ SIGNALS
CPU INTERFACE
SYSTEM
X-BUS
PIIX4
USB SIGNALS
POWER MGMT.
RP35 10K
RP36 10K
RP37 10K
RP38 2.7K
RP39 2.7K
RP40 2.7K
R92 8.2K
R93 2.7K
R94 1K
R95 8.2K
R96 8.2K
R97 8.2K CONFIG1
R98 8.2K
R99 1M
R100 0
R101 1K
C140 0.1uF
C141 10uF
C142 10pF
C143 10pF
C144 0.1uF
Y1 32.768KHz
D2 Bat54
D3 Bat54
D4 Bat54
BT1 BATTERY
J4 JUMP3
U13A 74LVC14
TP6
TP7
TP8
TP9
TP10
TP11
Keep crystal close to PIIX4 and caps close to crystal
Trace lengths should be equal
Do not populate. R112
1-2 Normal Operation
2-3 Clear CMOS
VSS - D10,E7,E13,J[9:12]
K[9:12],L[9:12],M[9:12]
VSSUSB J5
PIIX4E
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Title
PIIX4E Part 2
Size C
Document Number
Rev A3
Date: Tuesday, February 01, 2000
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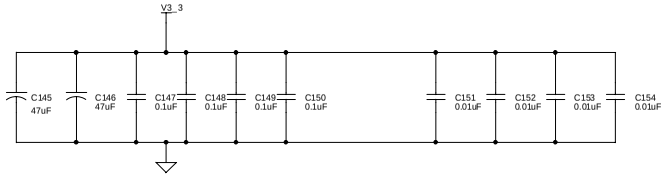
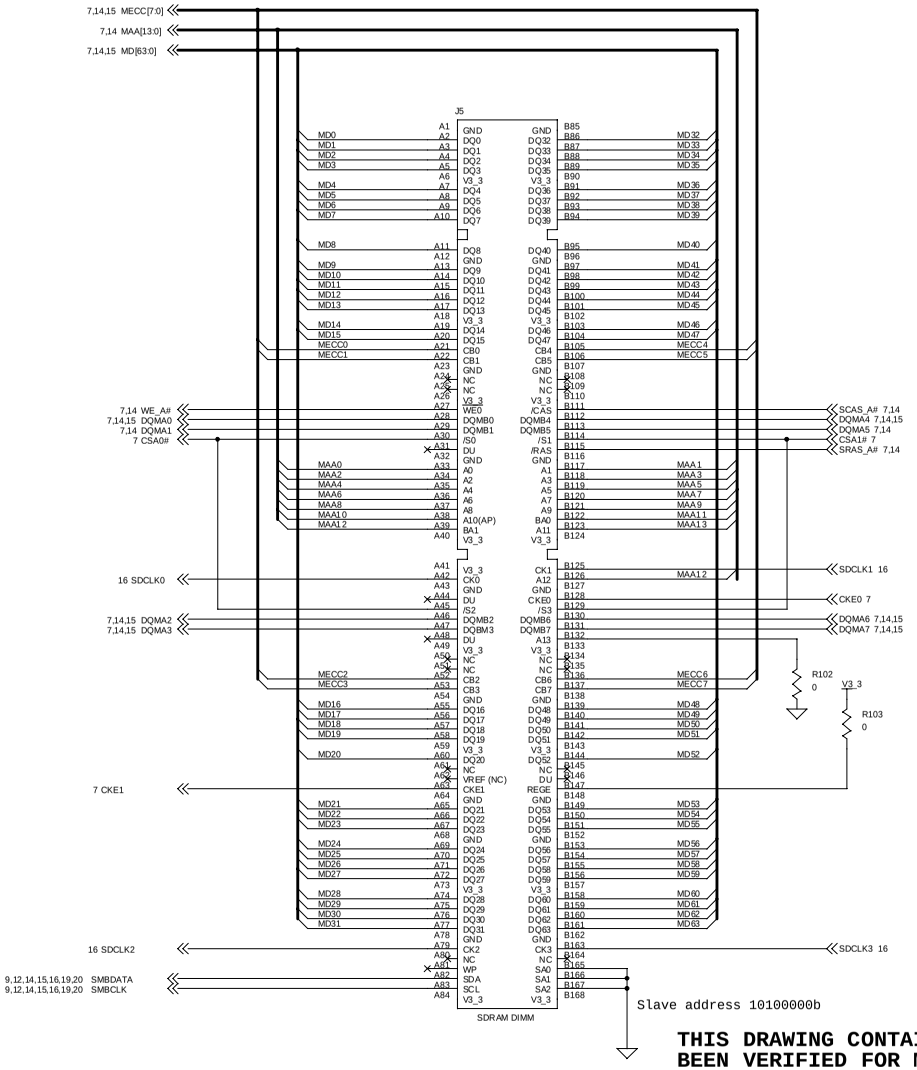


Socket 0



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Title: DIMM0

Size: C | Document Number | Rev: A3

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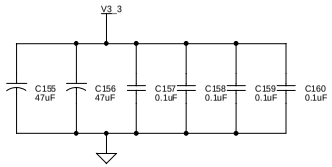
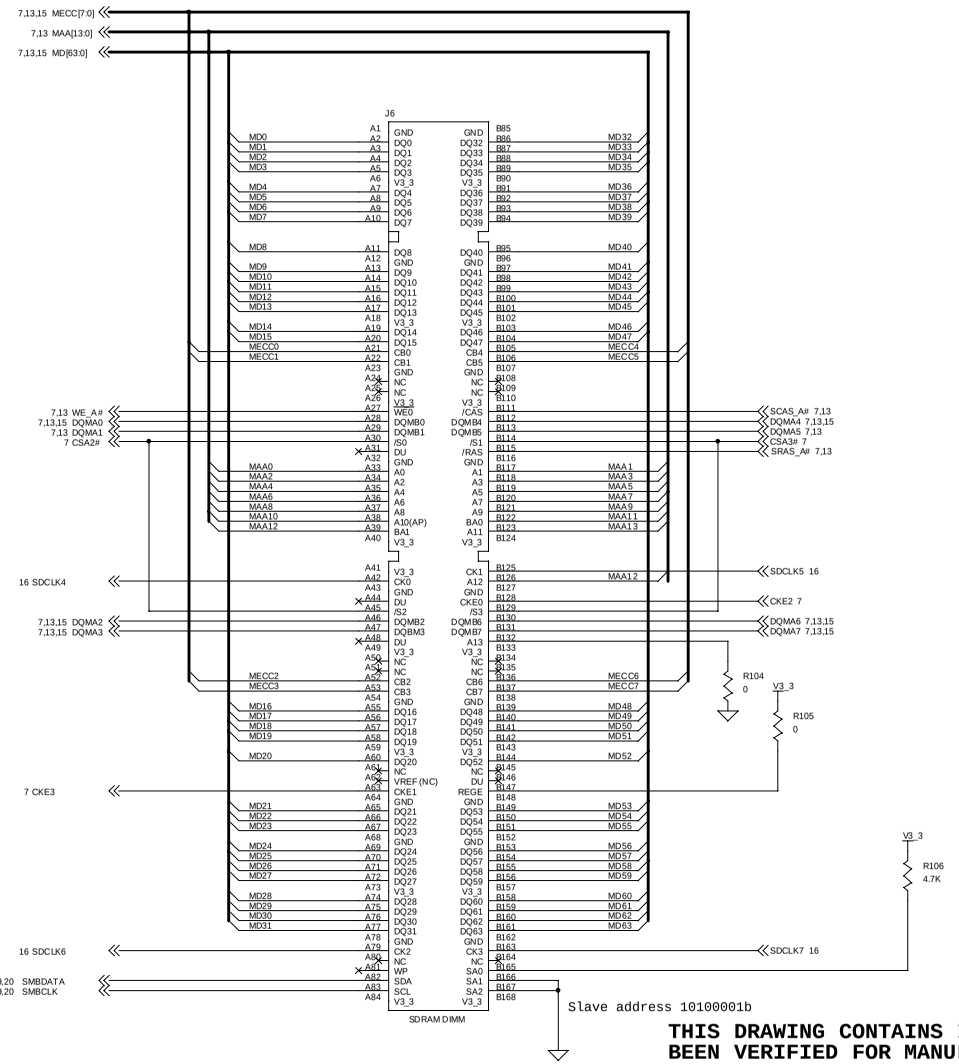


Socket 1



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Intel Corporation

Title: DIMM1

Size: C | Document Number | Rev: A3

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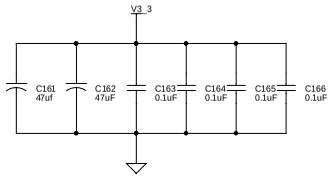
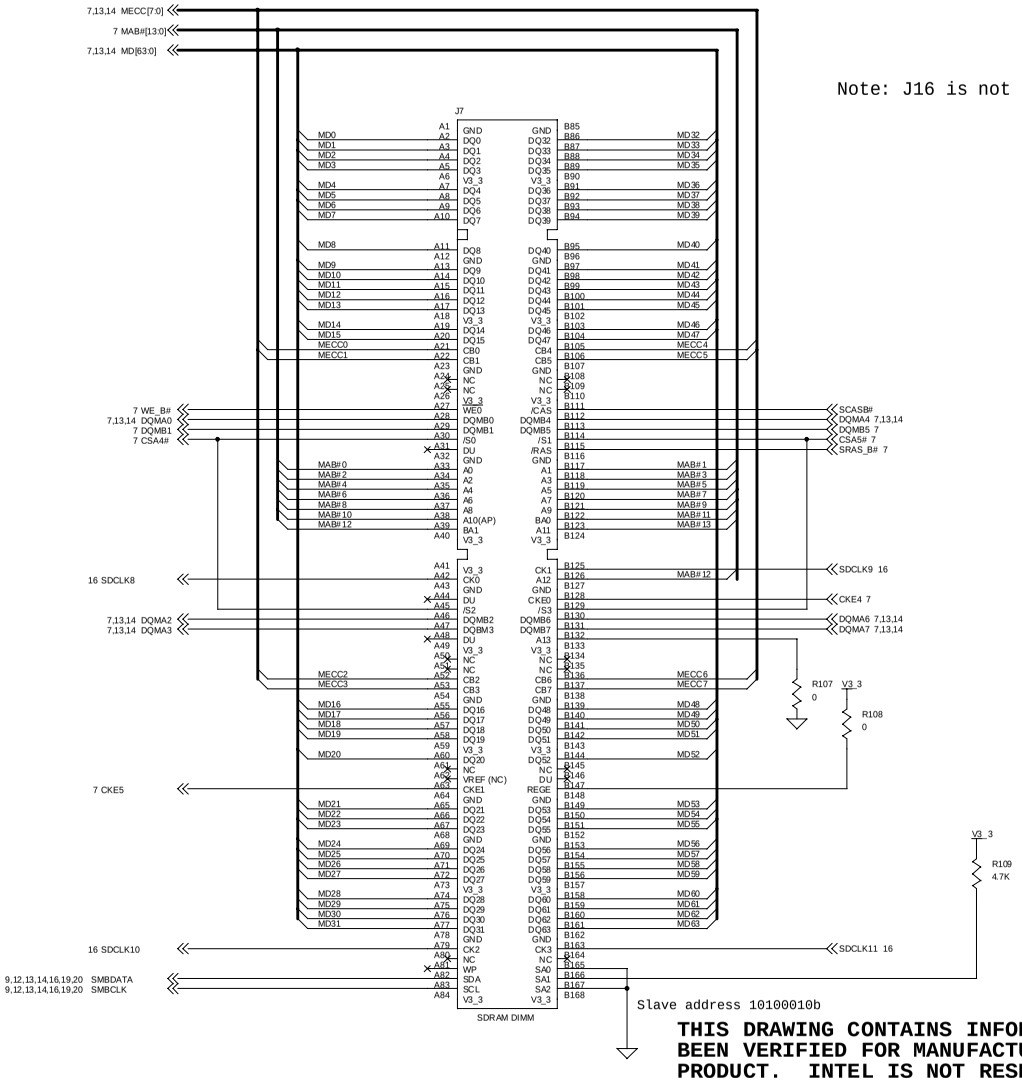


Socket 2

Note: J16 is not populated



Applied Computing Products Division Intel Corporation	
Title	DIMM2
Size: C	Document Number:
Rev	A3
Date:	Tuesday, February 01, 2000
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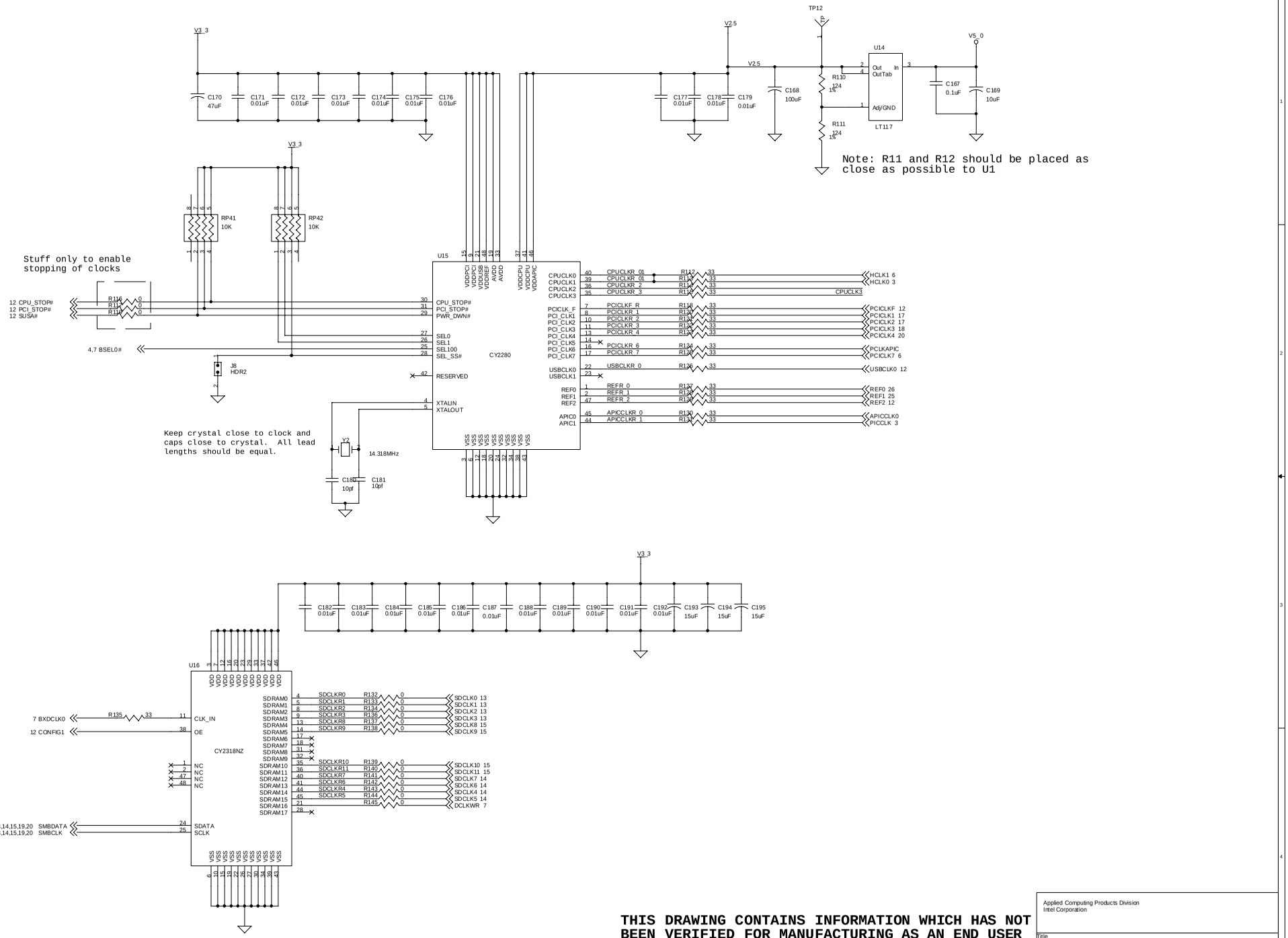

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Title: Clock Generator

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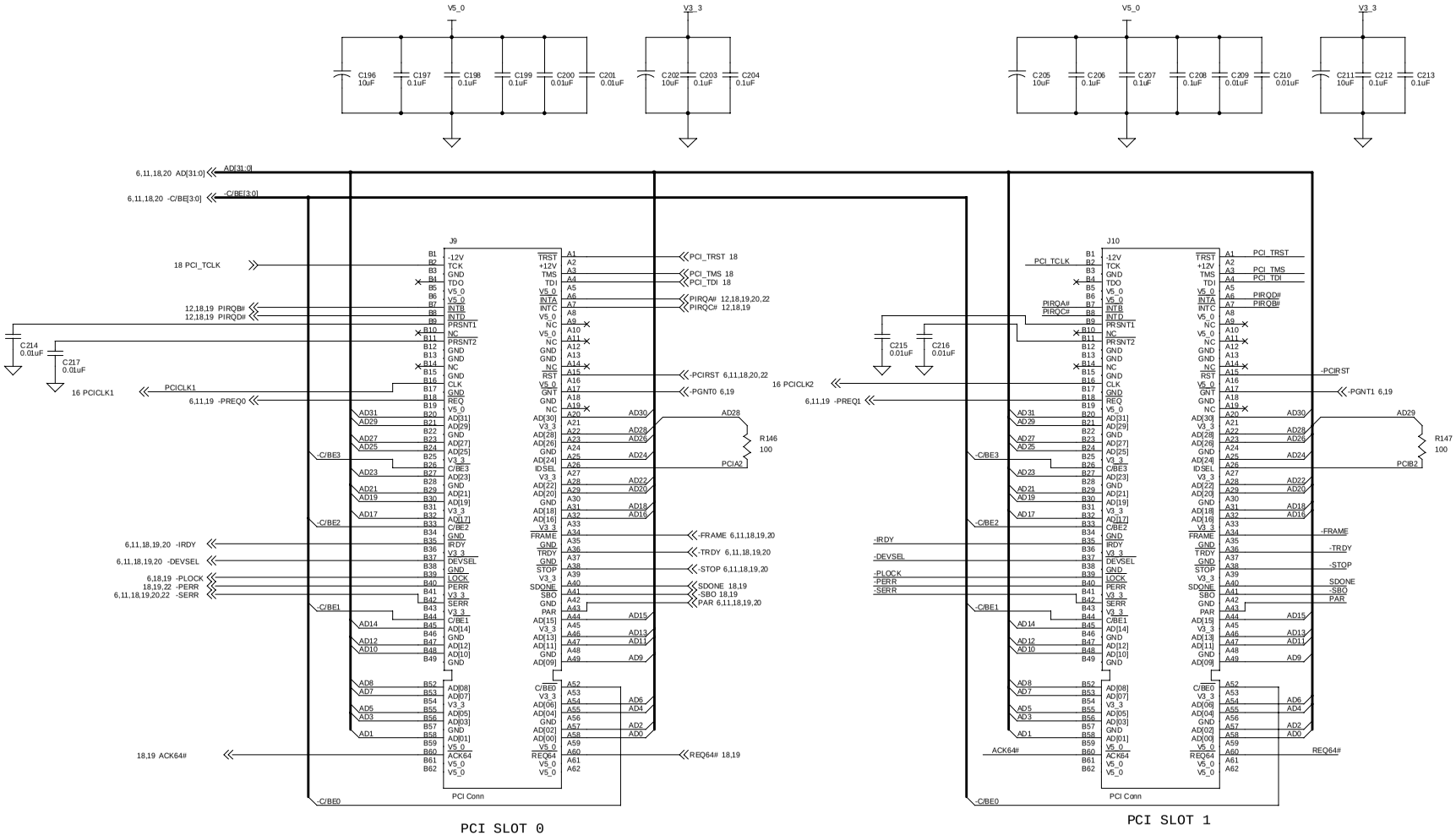
J10/J11/J12 V5_0:
    A5, A8, A10, A16, A59, A61, A62 | A1, A3, A4
    B5, B6, B19, B22, B59, B61, B62

J10/J11/J12 V3_3:
    A21, A27, A33, A39 A45, A53
    B25, B31, B36, B41, B43,
B54
J10/J11/J12 NC:
    A9, A11, A14, A19
    B10, B14

J10/J11/J12 GND:
   A12, A13, A18, A24, A30, A35, A37, A42, A48, A56
    B3, B12, B13, B15, B17, B28, B34, B38, B46, B49,
B57

J10/J11/J12
+12V: A2
      -12V:
B1



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Title: PCI Slot 0 & 1

Size: C | Document Number | Rev: A3

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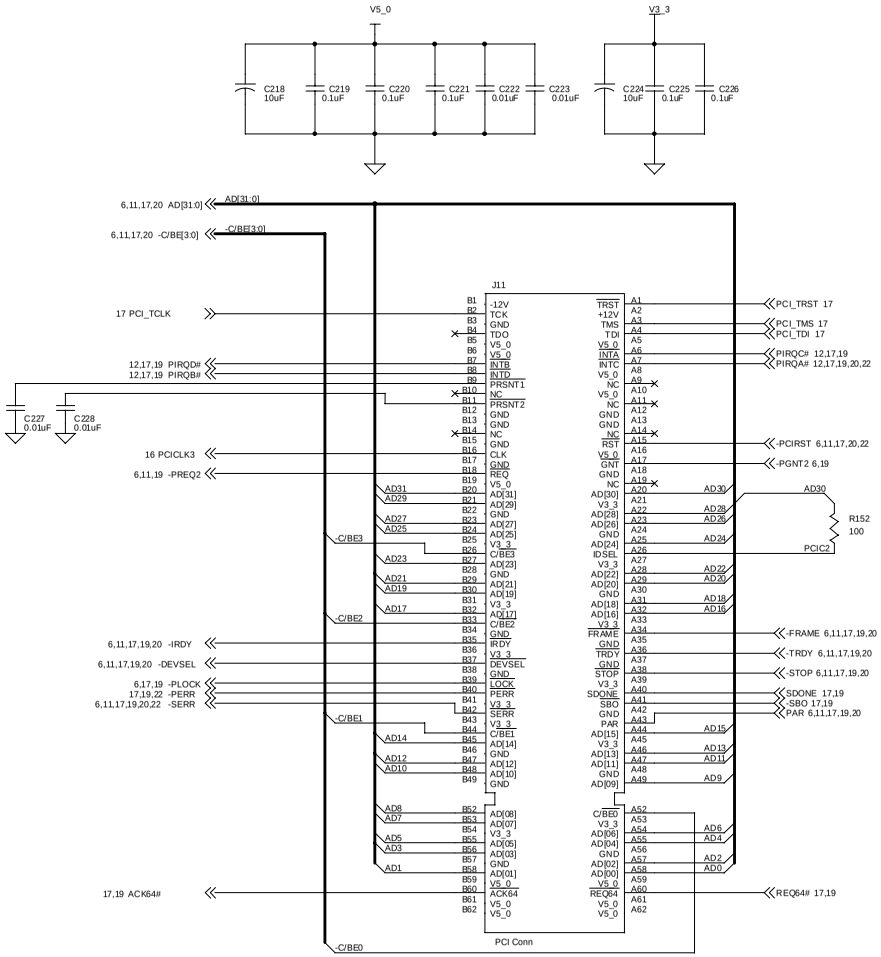
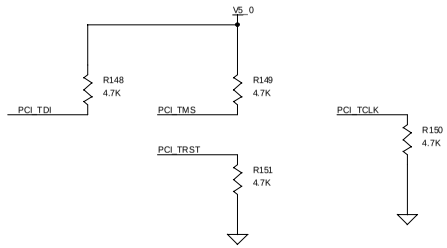


PCI SLOT 2



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Applied Computing Products Division
Intel Corporation

Title: PCI Slot 2

Size: C | Document Number | Rev: A3

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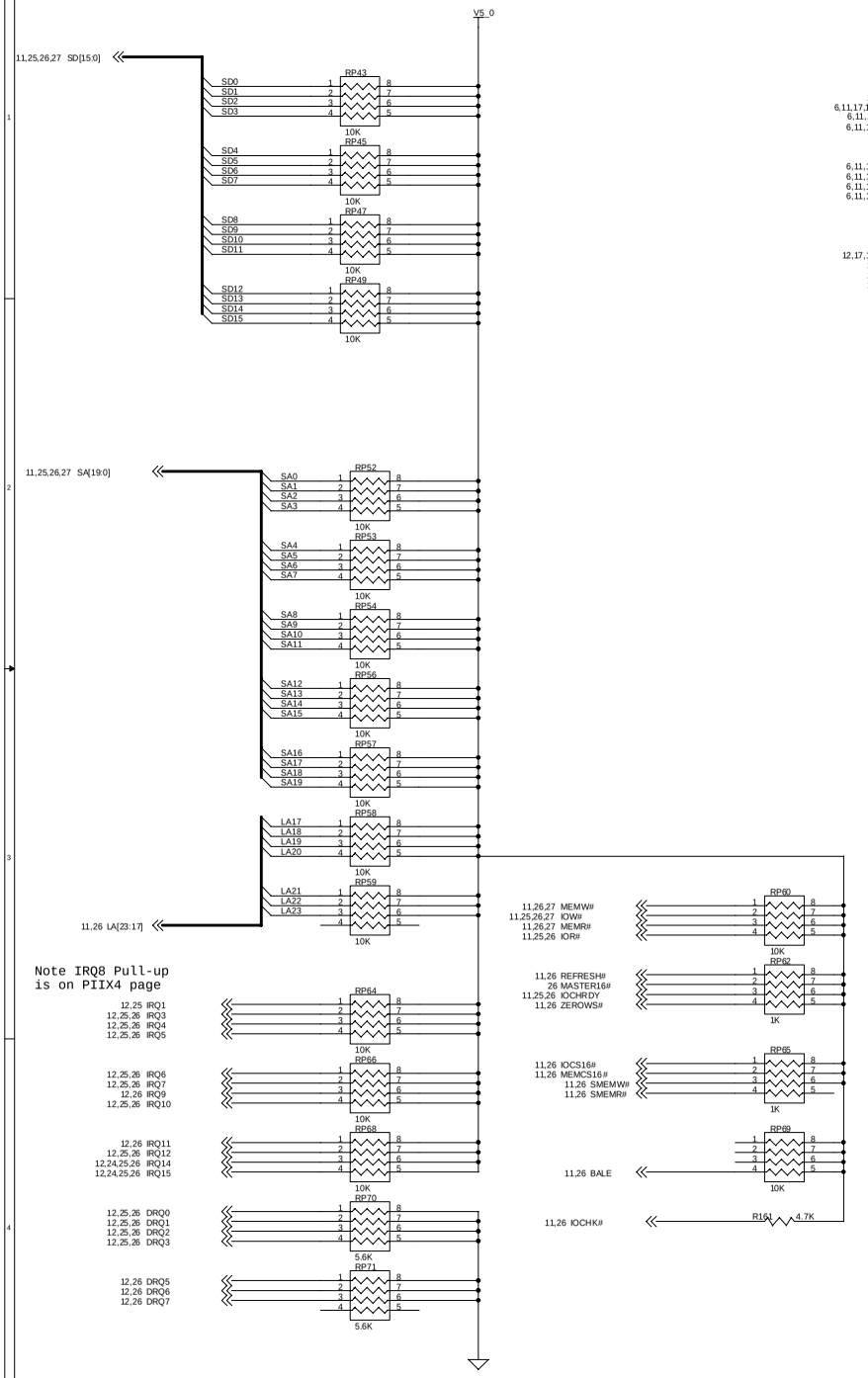
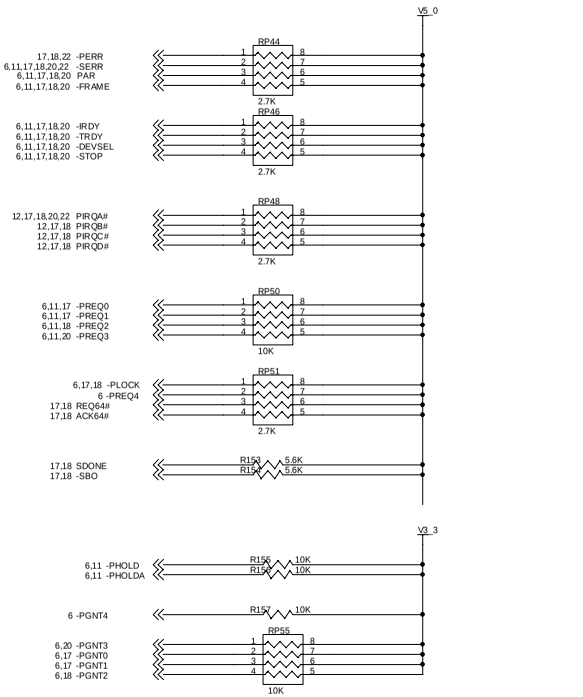
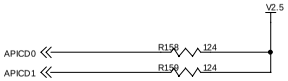
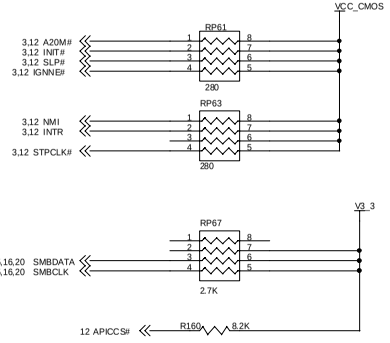
ISA Pullups



PCI Pullups







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Applied Computing Products Division Intel Corporation	
Title	ISA & PCI Pull-up
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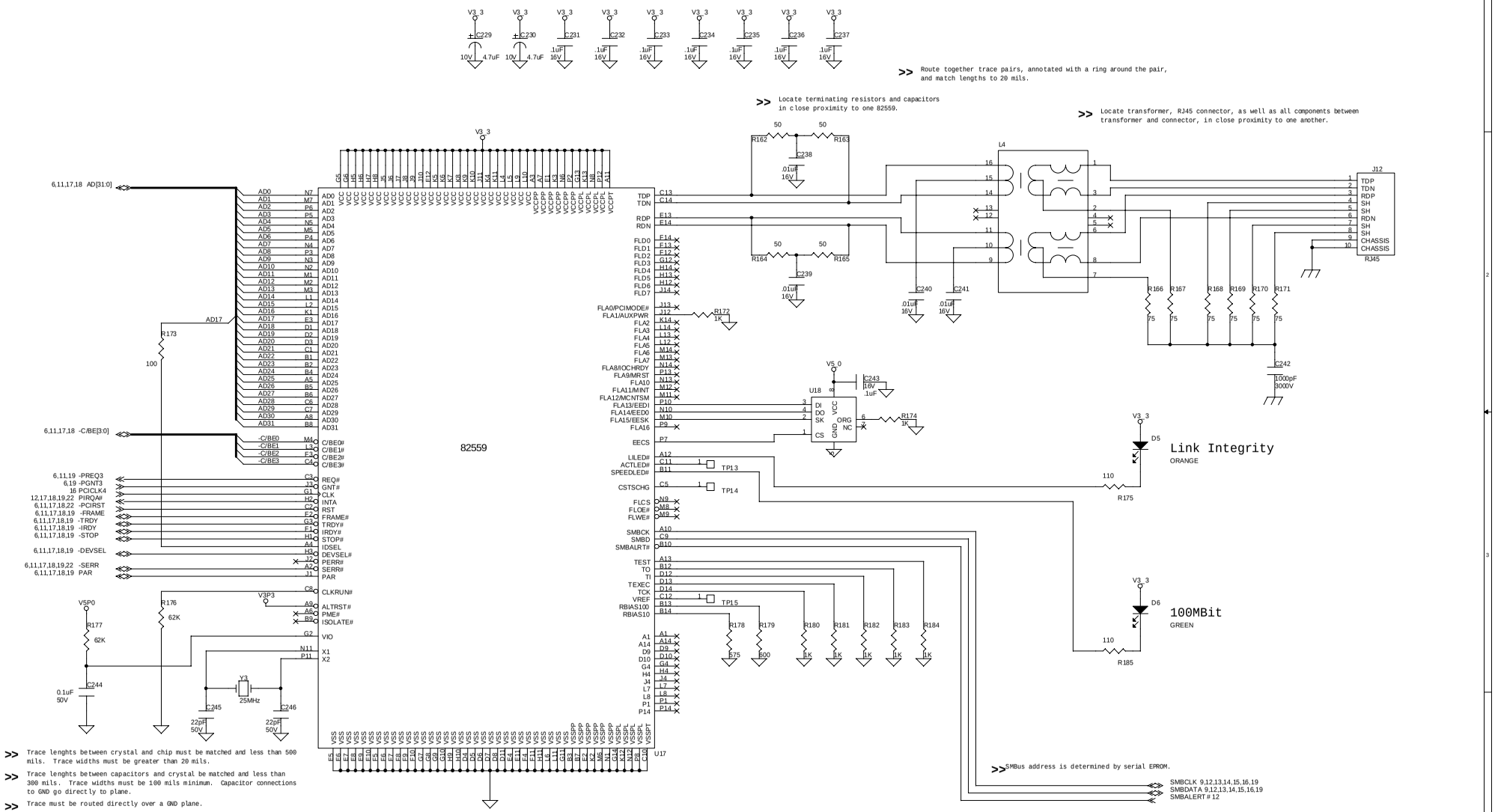

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Applied Computing Products Division Intel Corporation			
Title: 82559 Ethernet Controller			
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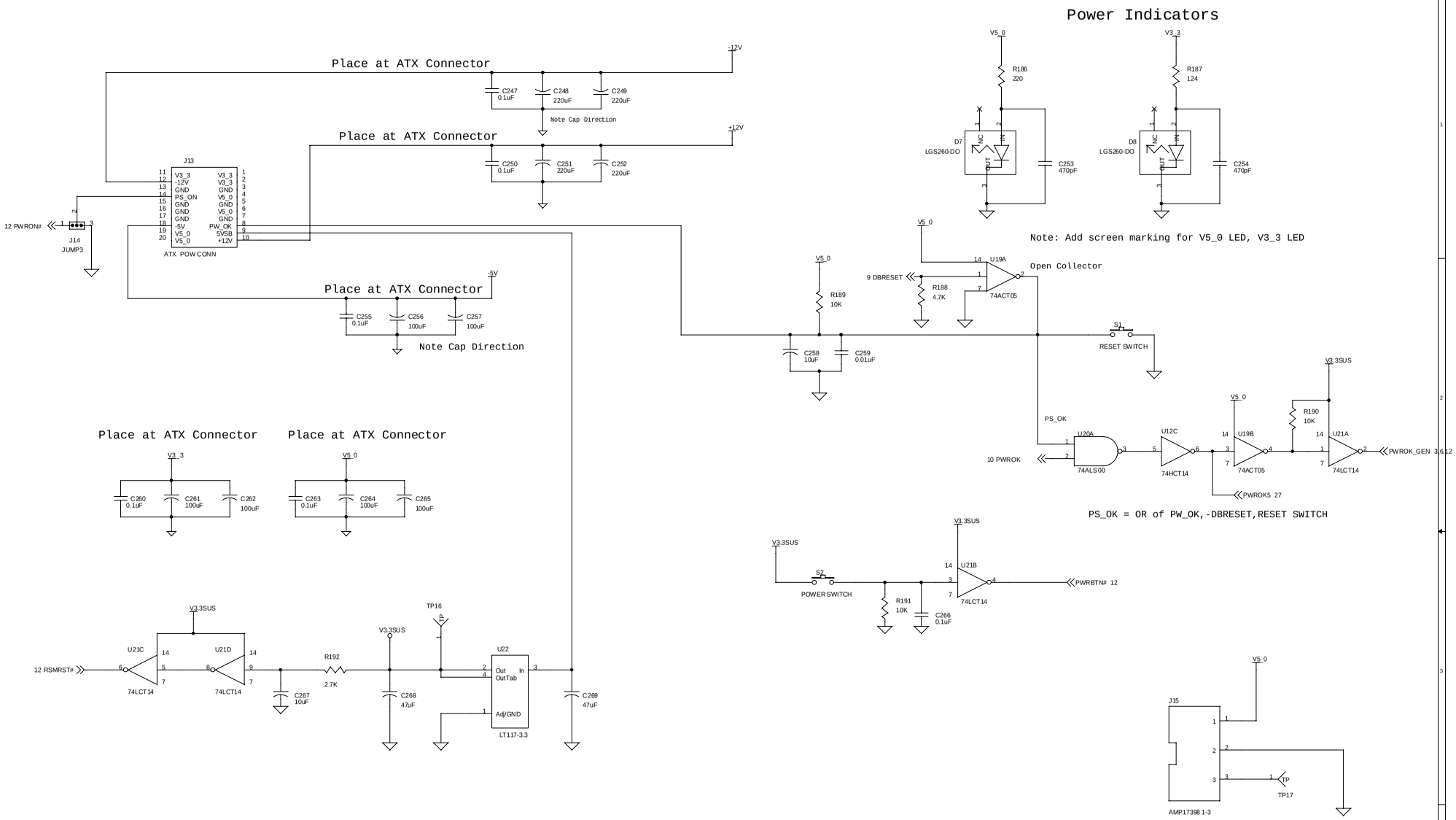

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Applied Computing Products Division Intel Corporation	
Title	ATX Power Supply
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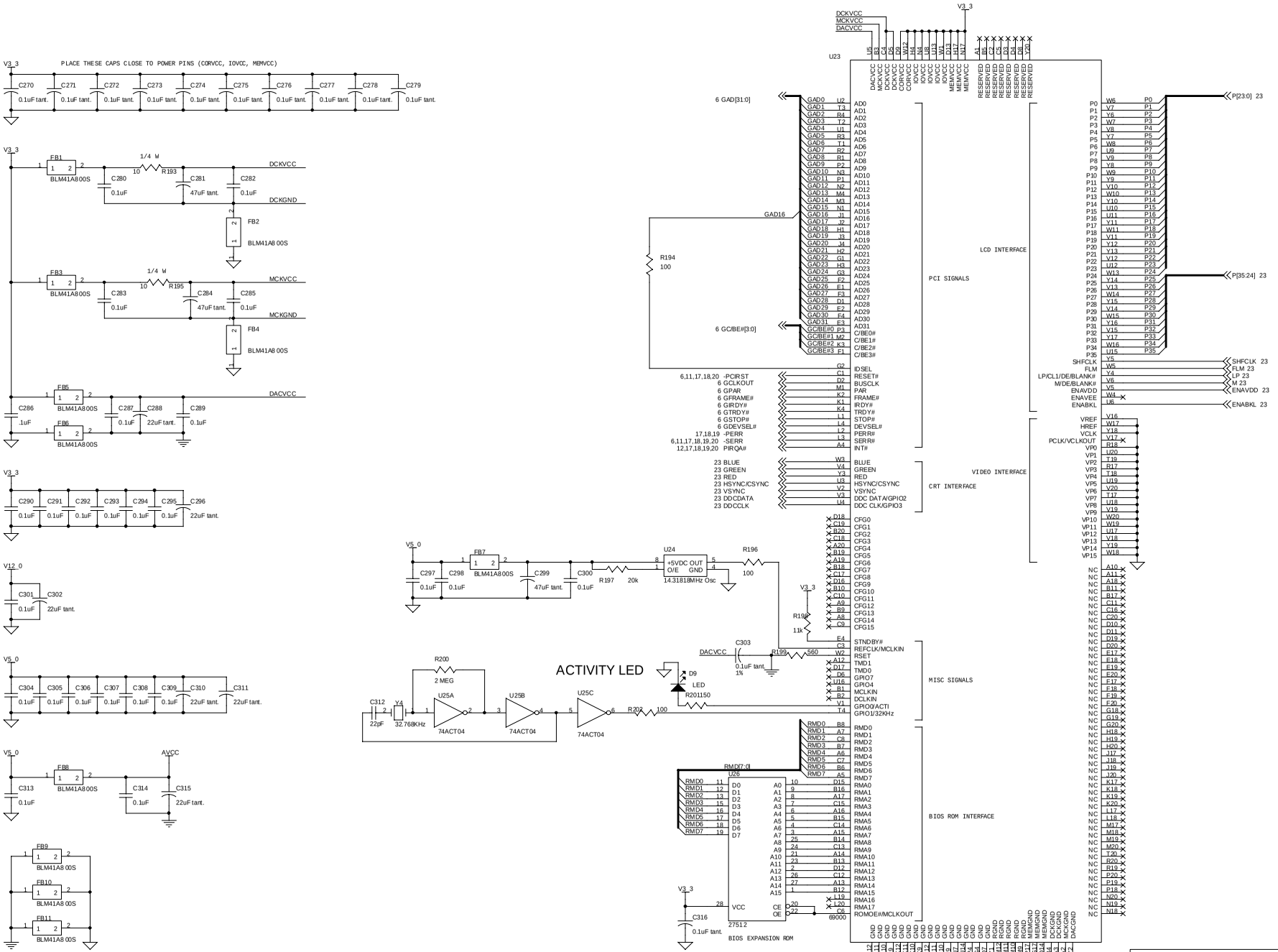
Date: Tuesday, February 01, 2000	Sheet 21 of 30



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Applied Computing Products Division
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Title: 69000 Graphics Controller Part 1

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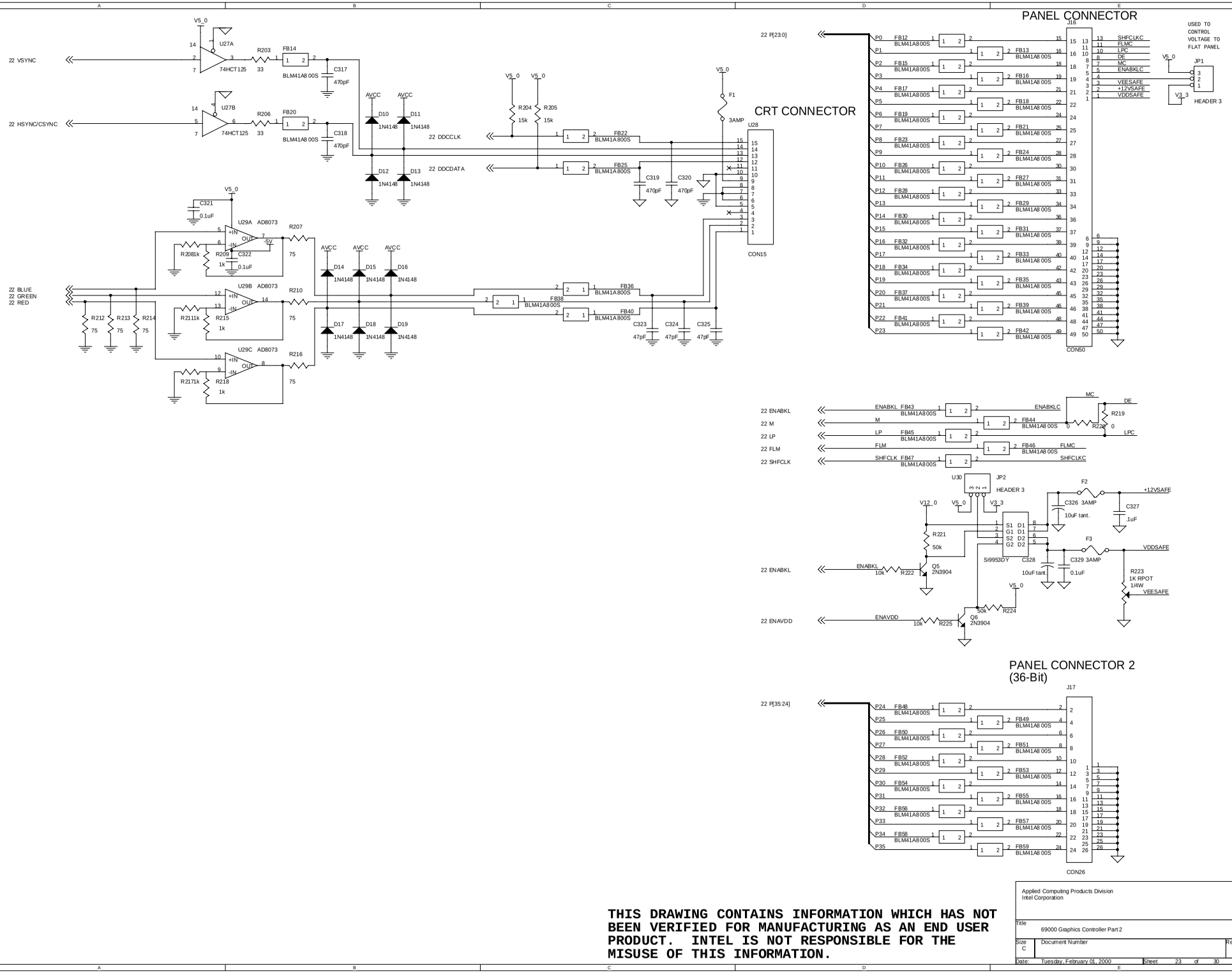

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Title: 69000 Graphics Controller Part 2

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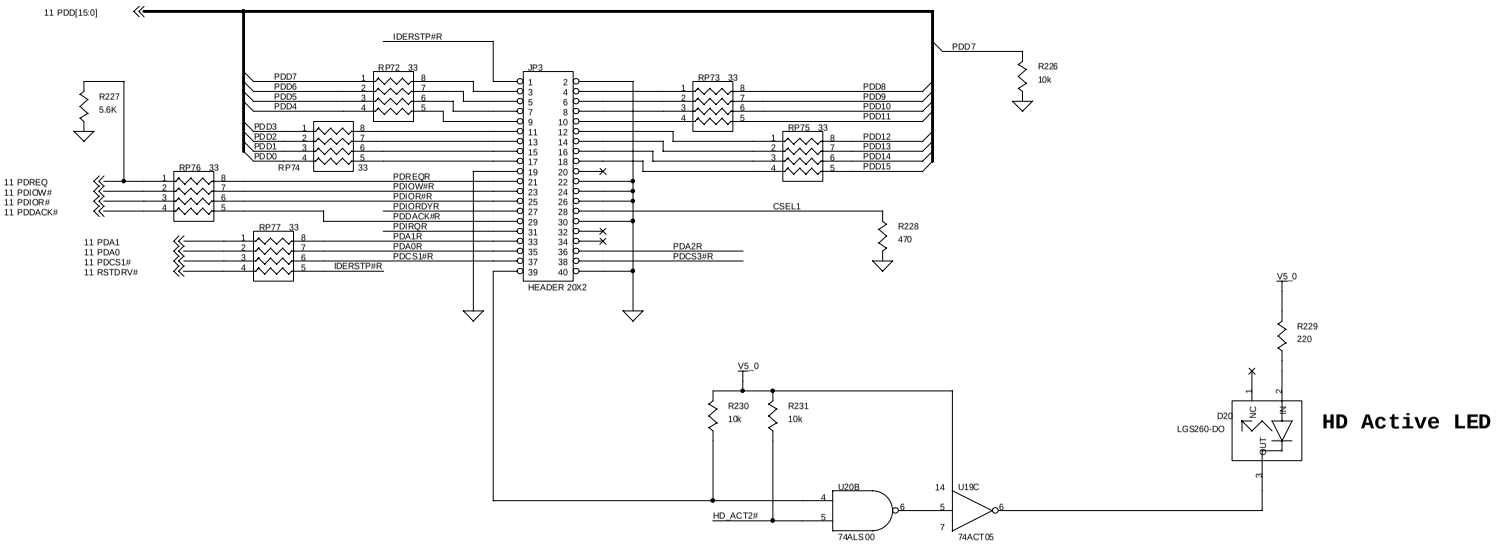
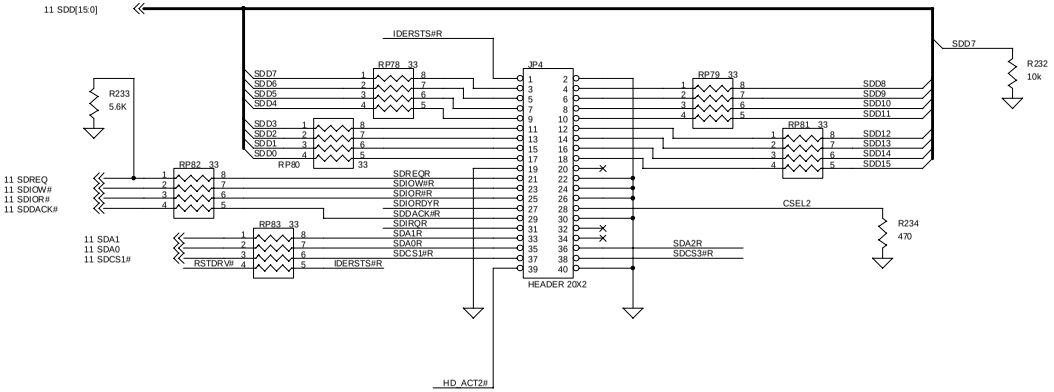
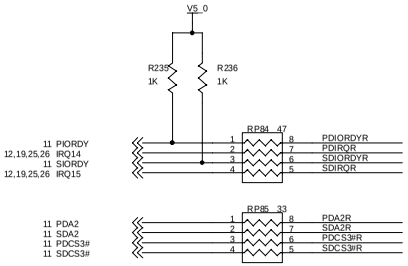
Primary IDE Connector



Secondary IDE Connector





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Title: IDE Connectors

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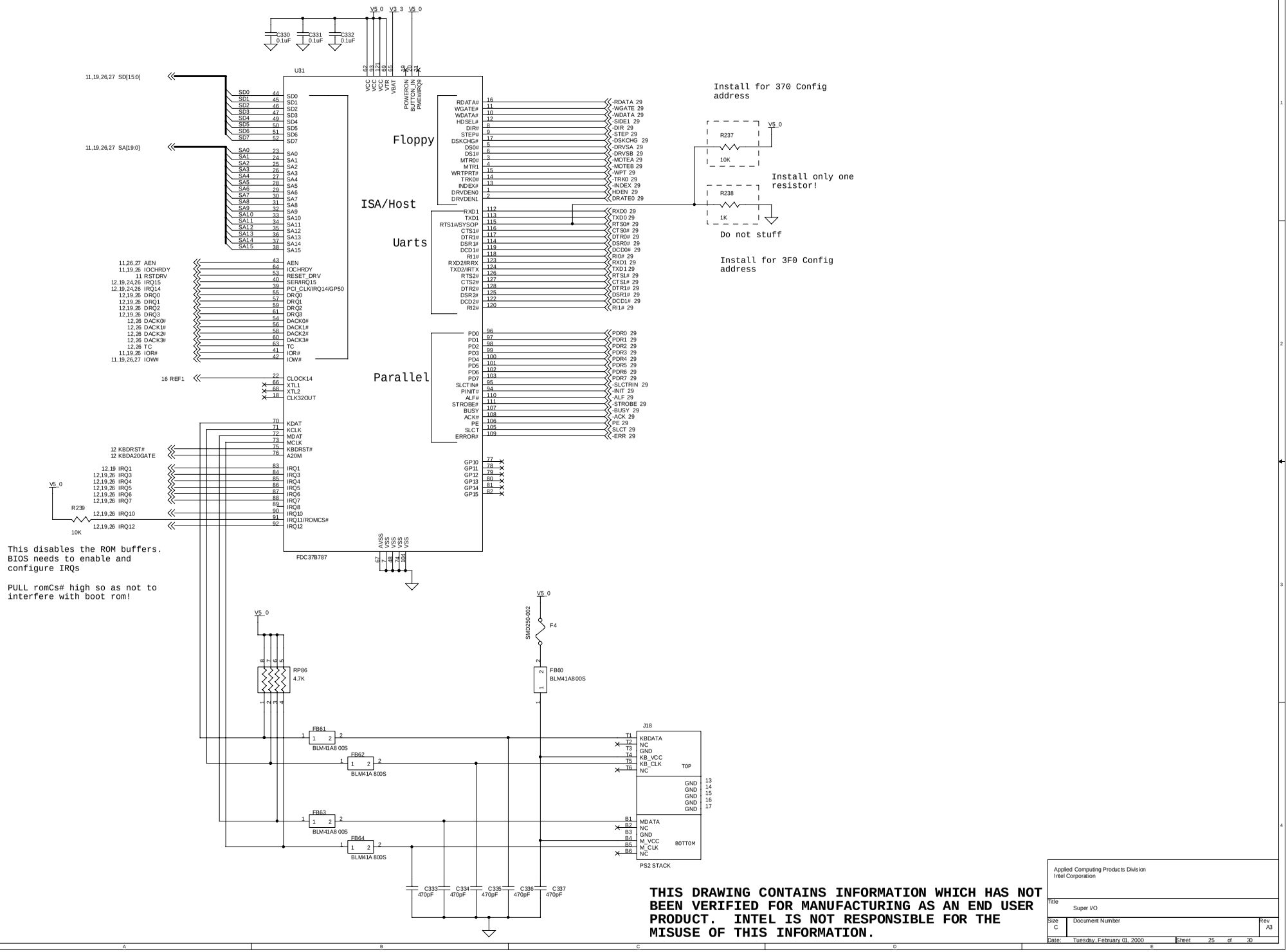

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Applied Computing Products Division
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Title: Super I/O

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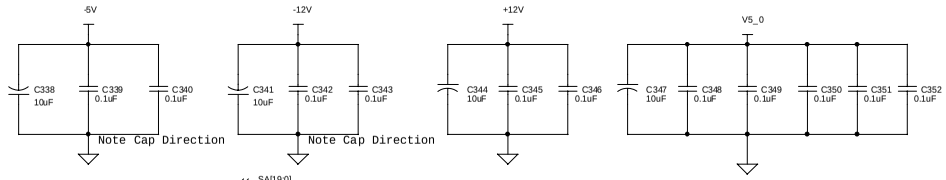
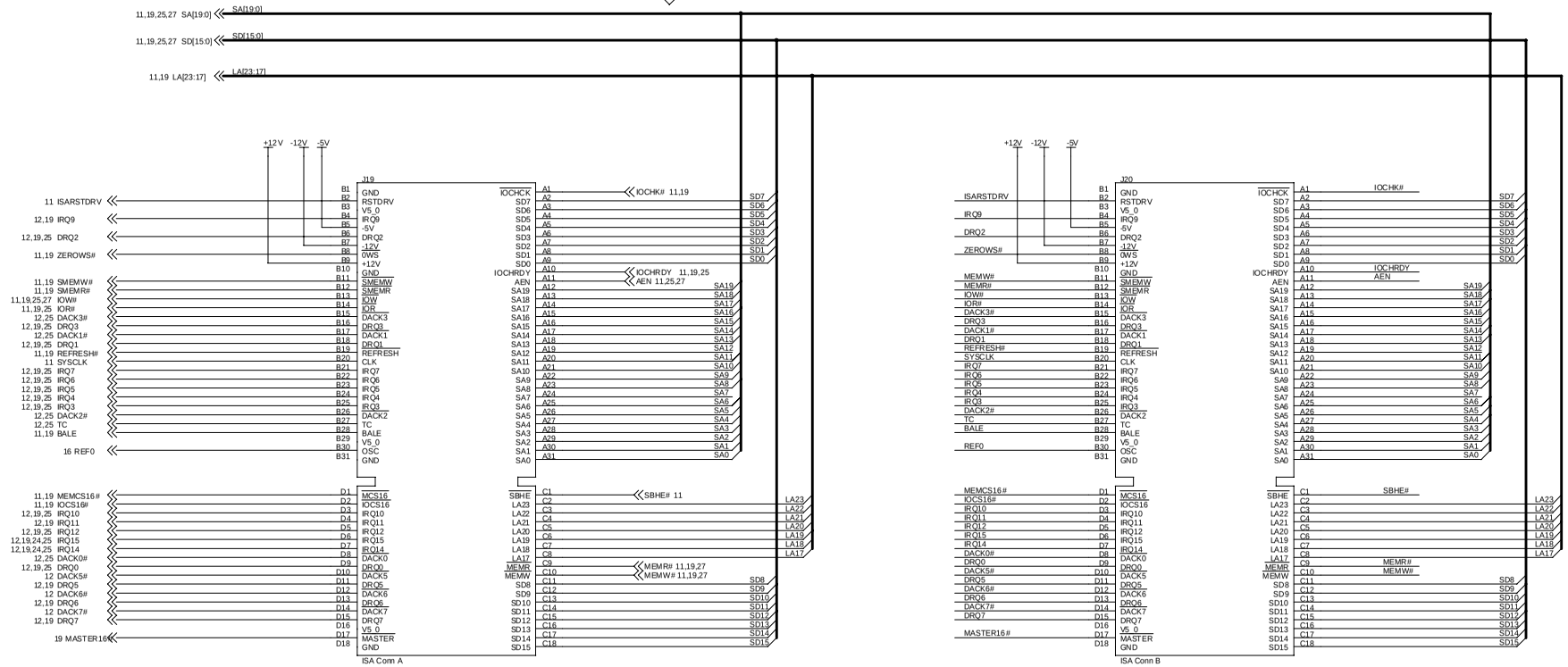
ISA Slots





J5/J6 V5_0:
B03, B29, B31, D16

J5/J6 GND:
B01, B10, D18

J5/J6: +12V B09
-12V B07
-5V B05

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Title: ISA Connectors

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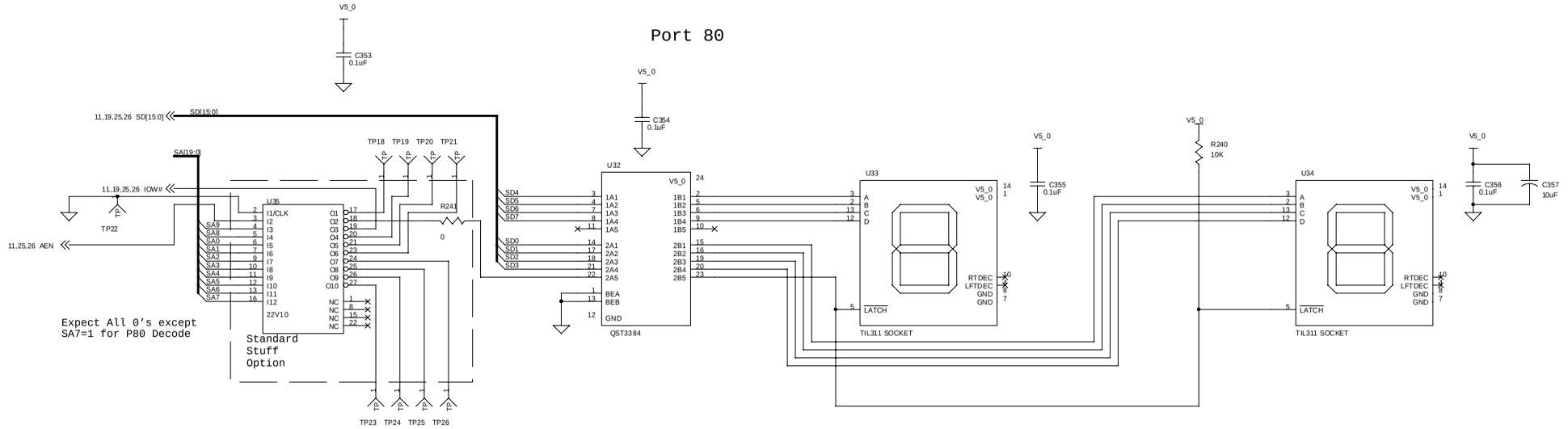
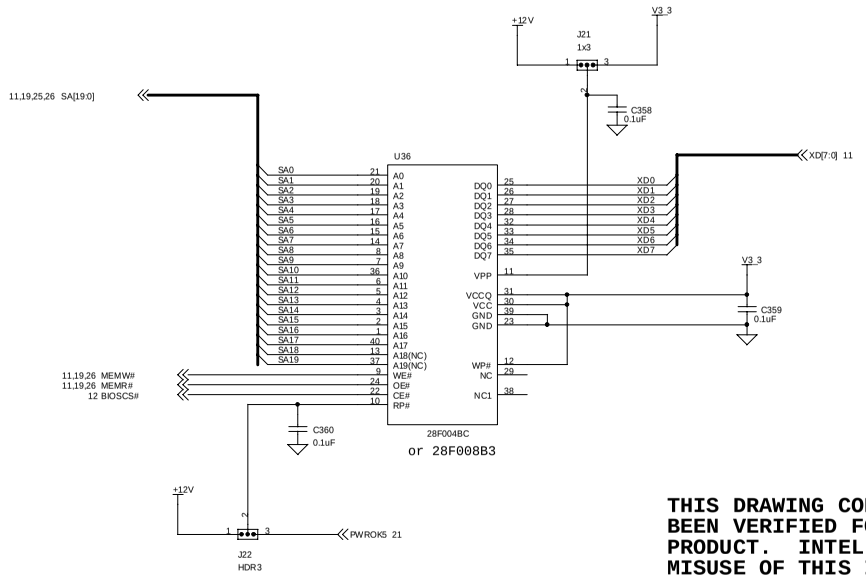
Port 80





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Applied Computing Products Division Intel Corporation	
Title	Flash BIOS & Port80
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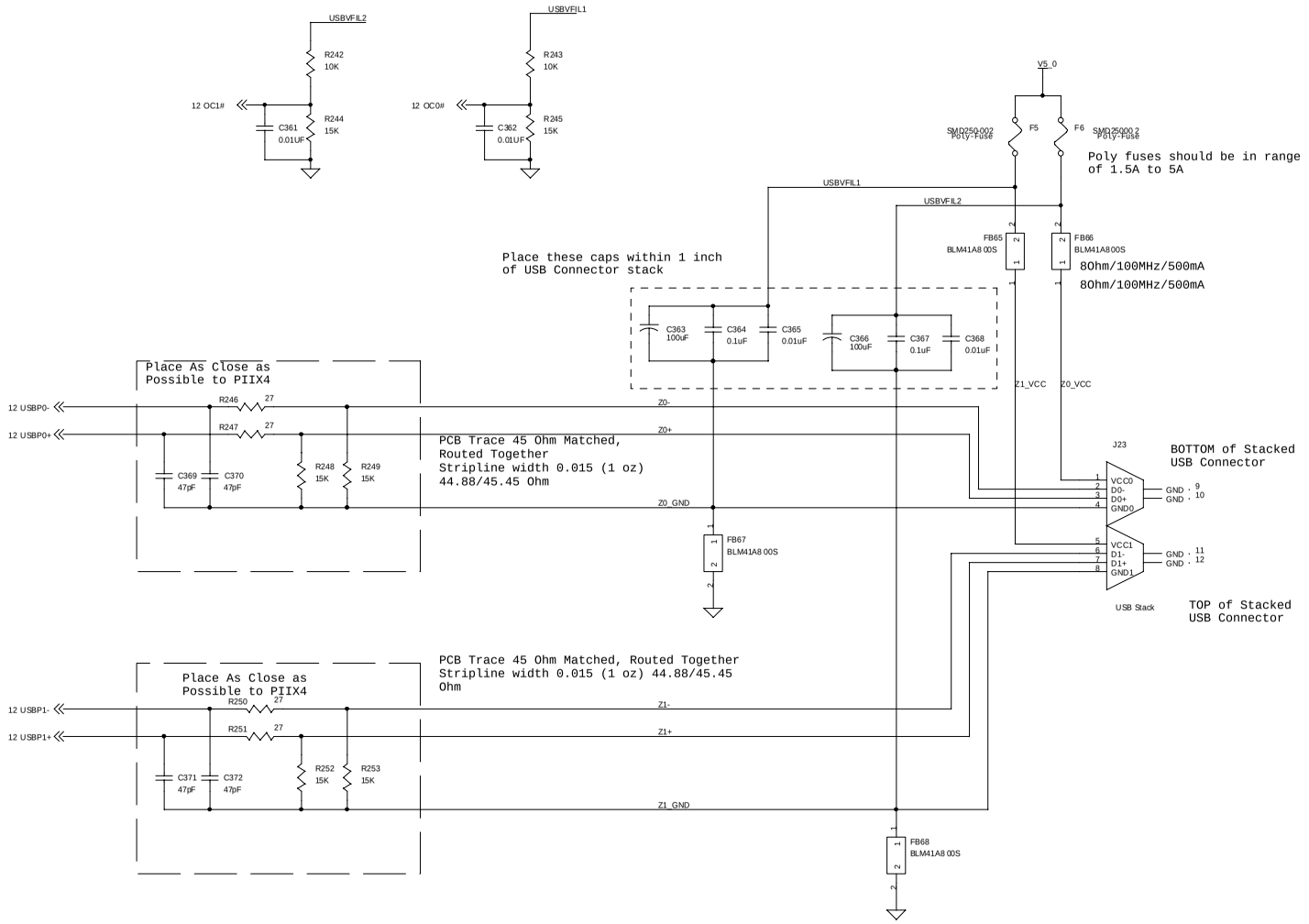

NOTE 1: USB differential traces route together (Z0- & Z0+) and (Z1- & Z1+).
Must be 45 Ohm Matched
Stripline width 0.015 (for 1 oz)->44.88/45.45 Ohm.

NOTE 2: Protect differential traces w/ guard traces or
double space to any other signal.

NOTE 3: Place ferrites at connector.

NOTE 4: Poly-fuse min 1.5A
max 5A.

Applied Computing Products Division Intel Corporation	
Title	USB Connectors
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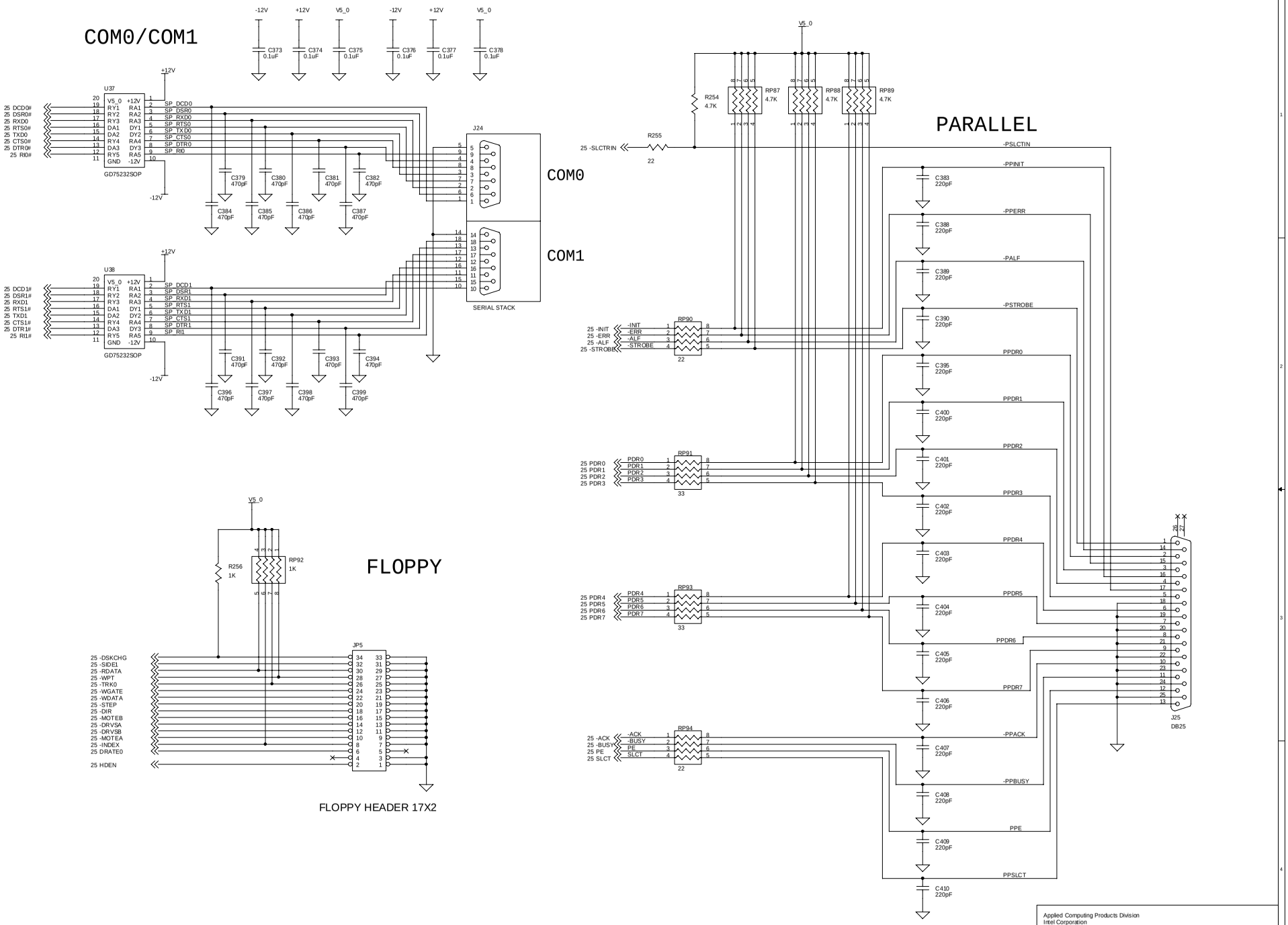
COM0/COM1
-12V
+12V
V5_0
C373 0.1uF
C374 0.1uF
C375 0.1uF
C376 0.1uF
C377 0.1uF
C378 0.1uF
U37
GD75232SOP
SP_DCD0
SP_DSR0
SP_RXD0
SP_RTS0
SP_TXD0
SP_CTS0
SP_DTR0
SP_RI0
25 DCD0#
25 DSR0#
25 RXD0
25 RTS0#
25 TXD0
25 CTS0#
25 DTR0#
25 RI0#
C379 470pF
C380 470pF
C381 470pF
C382 470pF
C384 470pF
C385 470pF
C386 470pF
C387 470pF
J24
COM0
COM1
SERIAL STACK
U38
SP_DCD1
SP_DSR1
SP_RXD1
SP_RTS1
SP_TXD1
SP_CTS1
SP_DTR1
SP_RI1
25 DCD1#
25 DSR1#
25 RXD1
25 RTS1#
25 TXD1
25 CTS1#
25 DTR1#
25 RI1#
C391 470pF
C392 470pF
C393 470pF
C394 470pF
C396 470pF
C397 470pF
C398 470pF
C399 470pF
FLOPPY
R256 1K
RP92 1K
JP5
25 -DSKCHG
25 -SIDE1
25 -RDATA
25 -WPT
25 -TRK0
25 -WGATE
25 -WDATA
25 -STEP
25 -DIR
25 -MOTEB
25 -DRVSA
25 -DRVSB
25 -MOTEA
25 -INDEX
25 DRATE0
25 HDEN
FLOPPY HEADER 17X2
PARALLEL
R254 4.7K
RP87 4.7K
RP88 4.7K
RP89 4.7K
R255
22
25 -SLCTRIN
-PSLCTIN
-PPINIT
-PPERR
-PALF
-PSTROBE
C383 220pF
C388 220pF
C389 220pF
C390 220pF
C395 220pF
C400 220pF
C401 220pF
C402 220pF
C403 220pF
C404 220pF
C405 220pF
C406 220pF
C407 220pF
C408 220pF
C409 220pF
C410 220pF
RP90
25 -INIT
25 -ERR
25 -ALF
25 -STROBE
-INIT
-ERR
-ALF
-STROBE
RP91
25 PDR0
25 PDR1
25 PDR2
25 PDR3
PDR0
PDR1
PDR2
PDR3
RP93
25 PDR4
25 PDR5
25 PDR6
25 PDR7
PDR4
PDR5
PDR6
PDR7
RP94
25 -ACK
25 -BUSY
25 PE
25 SLCT
-ACK
-BUSY
PE
SLCT
PPDR0
PPDR1
PPDR2
PPDR3
PPDR4
PPDR5
PPDR6
PPDR7
-PPACK
-PPBUSY
PPE
PPSLCT
J25
DB25
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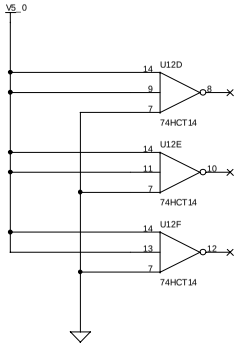

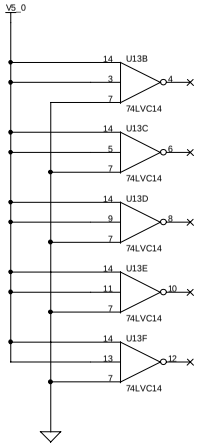

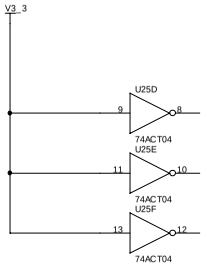

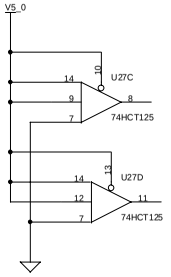

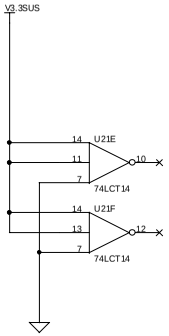

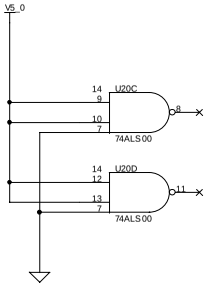

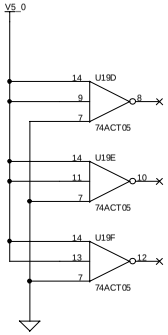

Applied Computing Products Division Intel Corporation		
Title: Unused Devices		
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